# PRINCIPLES AND PROBLEMS OF RIGHT THINKING

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HARPER & BROTHERS

D-D

TO
MY TEACHERS
YOUNG AND OLD

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*Part I*

# THE NATURE, IMPORTANCE, AND DIFFICULTY OF RIGHT THINKING

CHAPTER ONE

# TYPES OF THINKING

WHEN do we think?

When do we ....

On consideration we shall probably answer that whenever we are awake and conscious we are thinking—at least in some sense. In our humorous moods, or impressed by the unsubstantiality of much that goes through our minds, we may be tempted to deny this fact. All are familiar with the old rustic who, on being questioned as to how he spent his time, replied, "Sometimes I set and think, and sometimes I just set." And a rather unimaginative damsel is reported to have answered her lover's jealous appeal, "Darling, do you always think of me?" with a return that was no doubt sufficiently appeasing, "Yes, dear, whenever I am thinking at all." On careful examination, however, we find that such witticisms exaggerate. During our waking hours something, however vague and profitless, is always flitting through our minds, and the amount and variety of it, as revealed to introspective analysis, may rather startle us. As Robinson remarks, "Our thought moves with such incredible rapidity that it is almost impossible to arrest any specimen of it long enough to have a look at it. When we are offered a penny for our thoughts we always find that we have recently had so many things in mind that we can easily make a selection which will not compromise us too nakedly."[1] In fact, there is ground for suspecting that one of the reasons for our tendency to suppose that we are not always thinking is the very wealth and variety of our mental activity, making it often difficult to recover in retrospect anything precise enough to be easily called a definite thought.

[1] *Mind in the Making*, p. 37.

**What common forms does thinking take?**

But this conscious activity is obviously not all of the same sort. Let us examine a typical stream of it in order to distinguish the common forms which it takes. Consider the following experience.[1]

One calm summer morning, not long ago, I took my family for a ride in our little motor-boat down the shore of Lake Michigan. During part of the trip my thinking was so vague and effortless, and so pliable to the mood of the moment, that it is exceedingly difficult to recover it with confidence. There were the sensations of relaxed bodily comfort in the genial warmth of the sun and the gentle play of the breeze; there were the feelings of spontaneous muscular activity as I changed position in the boat from time to time, or found my attention attracted by this or that object around me. Then there were the free constructions of imagination, built by the passing mood in response to the cues offered by the environment, quickly waning and being abandoned as some new color, shape, or sound forced itself upon my attention. The steady purring of the motor reminded me of the earlier time when I had had difficulty in adjusting the flow of gas to the carburetor, and suggested how much more fun it would be to have an engine geared to secure much greater speed than this one could achieve at best. The small discharge of water from the cooling apparatus made me think of the order I had recently sent in for a new pump cam to replace a badly worn one, and I told myself that I must not run the motor too long before the replacement had been made, lest the engine be overheated. The succession of sand bars extending irregularly out into the lake from the shore became the stimulus for my imagination to picture playfully a war between different schools of fishes, who used these bars as natural ramparts for protection and cover in attack. And so on without end whenever nothing more incisive appeared to control my thinking in any more fruitful fashion, attention being caught by this or that feature of the environment and furnishing material for spontaneous

[1] In fact, elements of two separate experiences, selected to make the illustration more adequate.

imaginative play until some new stimulus became sufficiently powerful to check and replace it.

At times this succession of vague sensations and loose fancies passed into the experience of appreciative enjoyment of some feature of the scene through which we were passing. Objects did not become merely brief cues for imaginative construction, but some of them were able to attract and hold attention on their own account, as having in themselves, so to speak, the resources necessary to yield continued satisfaction. The blue of the lake, as it shifted its pattern under the puffy clouds screening it here and there from the sun; that lone clump of birches giving the knoll on which it grew a white crown above the green mantle of the pines below; these will exemplify, from the trip mentioned, those many common experiences which suddenly surprise us with beauty and hold our thoughts eagerly captive while they give up their riches to our admiring contemplation.

But a large, apparently concrete slab set up on the shore ahead attracts our attention. We draw up opposite it and stop. On it are inscribed the words: "On this spot was made the first settlement of ——, by ——, in the month of ——, ——. Erected —— by the Historical Society of ——." We had hardly absorbed this information when one of us noticed a strange dark object floating out in the lake some distance farther on. As we wondered what it might be we saw several people gathered on the shore opposite it. We started the motor and moved toward them. Soon a man emerged from the group and ran down the beach to meet us. When we were near enough he dashed out into the water, clad, as we now saw to our surprise, only in his underclothes. In response to his frantic waving we drew up and stopped the motor. "There's a boy being carried out to sea in a barrel," he shouted. "He's going fast." "We'll get him," I called in reply, and started the engine. At once my thinking became a quite different sort of thing from any of the above types. The exigencies of the situation controlled it. First thought—shall I land my youngsters, so that there will be no danger of their causing anxiety and difficulty? For the drifting boy was already more than half a mile from shore, and was

swept on by a stiff offshore breeze. And it is not impossible for a small boat to be upset. No, for every moment is precious. The barrel must be harder to balance as it gets out in the waves caused by the offshore wind; furthermore, our boat is pretty steady for its size, and if I tell the children to sit down in the bottom they will both be safer and make an upset less likely. So I command them to sit in the bottom, and steer directly for the drifting barrel. As we approach, two other important questions need an answer. Is the boy self-possessed, or is he so nervous and excited that he might jump for the boat too soon and thus endanger us as well as his own chance of rescue? Can I bring the boat close to the barrel without tipping it over before we quite reach it? I slow down at a distance of a few rods and scan closely the boy and his conveyance. He seems quiet and is maintaining his balance as perfectly as the ripples permit. And under his weight the small craft seems fairly steady. So I greet him in a matter-of-fact tone, and stop the engine just far enough away so that the boat can glide up beside the barrel. He scrambles in—a moment sooner than would have been best, but none too soon for safety—and in a few minutes we have him ashore.

Day-dreaming or reverie

What different types of thinking are exemplified in this illustration? Well, let us distinguish them in order. First, much of the time was evidently occupied by a free play of conscious activity merely controlled by the mood of the moment. This is what we call *reverie* or *daydreaming*. Though vague, accidental, and almost worthless for anything beyond itself, it is, as Robinson puts it, "our spontaneous and favorite kind of thinking." By this is meant that most of our conscious life, and vastly more than we should like to admit, is occupied with precisely this lazy and undirected play of feeling and fancy. "On inspection we find that even if we are not downright ashamed of a great part of our spontaneous thinking, it is far too intimate, personal, ignoble, or trivial to permit us to reveal more than a small part of it. . . . We find it hard to believe that other people's thoughts are as silly as our own, but they probably are."[1] The

[1] *Op. cit.*, p. 37.

reader has doubtless plenty of opportunity to test the truth of this description for himself. Yet we must not upbraid ourselves for childishness in too harsh terms, since, as we shall see, thinking of this type is the only kind for us to fall back upon when the attraction or practical pressure which determines other types of conscious experience fails to hold us.

Æsthetic appreciation and acquisition of information

In the second place, there was æsthetic appreciation. This form of conscious experience is sufficiently identified in the illustration. Enjoyment of the beauties that surround us in nature and art is surely universal enough for no one to have difficulty distinguishing it from mere reverie, and it would as surely be violating common usage to deny the pertinence to it of the term thinking. A third type is exemplified in our securing information from the tablet. Here we were adding to our previous store of knowledge by absorbing a set of meanings expressed in the symbols of language, whose relation to the facts of experience which they denote has long since been familiar. For this reason such appropriation of knowledge offered by others may be accomplished so simply as to involve no conscious effort, yet it requires concentration of attention during the reading, and no one would deny it to be a form of thinking specifically different from those already enumerated.

The solution of a problem

But it is clear that a fourth kind of thinking is revealed in our illustration, very different from any of these three. In this case a problem urgently demanding solution has come upon us. Thinking gains at once in vividness and intensity. All our conscious resources are mobilized in an effort to reach a solution. The occurrence of the problem fixes a goal which we desire very much to reach—in this particular case, of course, the saving of the imperilled boy. Now a desired goal we express in common language as a *purpose,* and the purpose which appears when a problem thus commands our attention controls the ensuing activity until the problem either is solved or else baffles us so completely that we give it up as impossible, at least for the present. It is precisely the conscious or intellectual side of this ensuing activity that constitutes the type of thinking we are now analyzing. The purpose fixed by the problem guides our think-

ing, and the outcome of successive steps of the thinking process guides the subsequent action that is needed. A more detailed analysis of how this process develops will occupy us in chapter four. Suffice it here to note that the problem first breaks up into its component parts, which are then concentrated upon in order—as when I first raised the question whether to take the children ashore, and later considered how best to get the boy aboard—that in facing each part, suggestions of how it might be solved come to mind, which are then compared with the observed facts of the situation and with one another, and that when one of them appears in the light of this comparison sufficiently superior to the others to command action we proceed to act on it, and are then ready to face in the same way the next phase of the difficulty. Thinking of this fourth type is thus essentially a conscious tool for helping us meet the difficulties and surmount the perplexities against which life from time to time throws us. Following recent custom, we shall give it the special name of *reflective thinking*.

Another classification

It is worth observing, in passing, that there is a distinction of another sort made in common life which cuts across each of the four types above noted. This is the distinction between thinking in its widest sense as including everything that enters conscious life, and thinking as an inner train of ideas, opposed to what is directly present to the senses. Thus to the query "Did you say you saw So-and-so yesterday?" the answer might be, "No, I only happened to think of him." In connection with the matter of verification we shall have later to return to this distinction, but for the present we may neglect it.

Which forms may be improved?

Now let us approach the four types of thinking whose distinction has above occupied us, with a leading question.

Which of them is it possible to try to improve? The student who undertakes such a study as ours knows in a general way that it has to do with the correction of our thinking. Obviously the first type stands in a very different class from the other three in this respect. We might, of course, consider it desirable to improve our daydreaming, but we see at once that, strictly speaking, it would be quite impossible to do so. For the applica-

tion of conscious effort in the attempt to improve it would transform it so that it would no longer be daydreaming. The very essence of reverie is the free, unchecked and undirected play of sensation and imagination, in response to the mood of the moment. The only way it could be improved would be to make it more pliable to a controlling purpose. But such a controlling purpose would bring about thinking of the fourth type rather than the first. On the other hand, the other three forms of thinking would all seem to be improvable in some respects. There are difficult questions to be answered as to just what these respects are, and to what extent improvement can be justly expected, but at least there seems no *a priori* reason against its possibility. We commonly assume, surely, that it is possible to better our appreciation of beauty, our ability to assimilate readily the experience of others, and our capacity for effective solution of the problems which face us, and we point out cases where such improvement seems concretely to have been attained.

**What does it mean to improve our thinking?**

But just what would it mean to improve our thinking? It has been said above that improvement would involve rendering it more pliable to a controlling purpose. Let us consider more exactly what is contained in this assertion. And since the second and third forms of thinking brought out in our analysis carry a certain ambiguity at this point, let us turn to the form that we have called reflective thinking. A decisive contrast appears at once between this and daydreaming which is worth examination. Daydreams issue in no *belief which claims to correspond to some real fact in our world, and on which further action is based.* Now beliefs may be right or wrong, correct or incorrect. And from the nature of the resulting belief the adjectives are referred back by a natural metonymy to the process which culminated in them—thinking is accordingly right or wrong, correct or incorrect, true or false, as it proceeds or does not proceed in the manner appropriate to attaining true beliefs. Well, it is always (is it not?) matters to which these adjectives apply that we have in mind when we think of improving them. To improve anything is to make it correct instead of incorrect, right instead of wrong, or at least to bring about a definite change in this

direction. But reverie is certainly thinking of a sort which quite evades such description. It is not concerned with beliefs at all. It is spontaneous imaginative play, to which real facts as such are quite irrelevant. A reverie may be good or bad, entertaining or insipid, dramatic or dull, pretty or ugly, wild or sober, but it can hardly be right or wrong.[1] When I pictured the battle of the fishes across the submerged bars of the lake, I did not really believe that such battles actually took place. If I had done so I should have been a proper candidate for admission to an insane asylum, for the commonest forms of insanity consist precisely in mistaking reveries for real events. It was merely a fancy momentarily entertaining, to which the succession of bars as really perceived merely gave the sensory clue. To be sane and normal is to be able to hold fast the distinction between such fancies and genuine beliefs about the objects in question, such as, for example, that the fourth bar from shore is about six feet below the surface of the water. To make judgments of this sort, upon which one is willing to commit himself to action when occasion arises, is clearly to think in a way which may be right or wrong, and one very different from mere daydreaming. For there surely is some distance below the surface of the water which, if believed of the fourth bar, constitutes it a true, or right, or correct belief.

But discussion need not be expanded to show that the fourth type of thinking *is* occupied with beliefs about real things and gains its sole value and justification from its ability to yield and use correct beliefs. For the purpose which is fixed by the nature of the problem, and which controls the process of reflection, can only be attained by securing true beliefs instead of alternative false ones, either as themselves furnishing the answer to the problem (when the latter is theoretical in nature), or as necessary intellectual guides to its solution (when it is practical rather than theoretical). Thus when we were engaged in rescuing the boy from his barrel, the happy solution of our problem depended on our having correct beliefs, first as to the advisability of waiting to land the children before going

[1] Except perhaps in the moral sense of these terms.

after him, second as to his calm or excited condition, and third as to the steadiness of his craft. On true beliefs about these things the action fulfilling our purpose depended, and accordingly thinking was solely occupied in bringing to light relevant suggestions on just these points and weighing the evidence for their truth or falsity. It is exactly the close connection of thinking of this urgent, problem-solving sort with beliefs about real things that makes it possible for it to be right or wrong thinking. If it attains correct beliefs, on which whatever further action is demanded may dependably be based, it is right thinking; if it fails to do so it is wrong thinking. With two qualifications, indeed, the above statement will serve well as a definition. It must be qualified because of the facts that sometimes factors upset our calculations which could not at all be foreseen in advance, and that often the time available for reflection is not sufficient to yield the best solution that would otherwise be possible. Hence we may in the light of them *define right thinking as that which proceeds in the manner shown by experience to date to be most likely to reach correctness in the beliefs about real things at which it aims, in so far as made possible by the time available for decision.*

We are now prepared to return briefly to the ambiguity in types two and three, which we have temporarily neglected. Under what conditions is such thinking susceptible of correctness or incorrectness?

**In what sense is æsthetic appreciation right or wrong?**

To take type two first, if we mean by the appreciative activity there described mere personal absorption in the attractiveness of the scene, such as could be expressed in the words, "I like this," or "This looks pretty to me," the adjectives rightness and wrongness are surely just as irrelevant as in the case of daydreaming. It is simply an immediate fact, not a belief. It could not be false without ceasing to exist, and, therefore, as not appealing to evidence, but resting solely on its own character as real, it could not be true, either. But if in the experience we are endeavoring to apply an objective standard, such as would be expressed by the words, "This is beautiful," meaning that others must find it so as well as we, then clearly

we are dealing with beliefs that may be true or false and our thinking may correspondingly be right or wrong. For to mean "beautiful" is to mean something real and objective about the object of our thought, even though it be more difficult to locate precisely than such facts as colors, shapes, and the spatial relations between them. To be sure, I might catch myself saying mentally, "This is beautiful," when all that I had a right to say was, "It attracts me"; but if I really mean beautiful, with all that the word implies, I am committing myself to a belief about the objective æsthetic quality of the scene. For the immediate enjoyment itself could obviously not justify such an assertion about what others must find as well as I.

In what acquisition of information?

Somewhat different ambiguities command our attention when we turn to the third form of thinking noted. In the first place it is clear that the thinking does issue in a belief about real facts: I accept the statement on the tablet as historically true and connect it with the rest of my historical knowledge as an item of truth to be taken for granted in any possible further use of it. But when we speak about improvement here we may mean two different things. If the language is at all unfamiliar, we may mean overcoming our difficulty in apprehending the meaning of the symbols. On the other hand, we may mean overcoming a tendency to accept too uncritically information thus acquired as trustworthy.

Emergence of the main problems of logic

Two fundamental points now emerge, which give us an outline of our further procedure. One is, that if perplexity should appear about any of the beliefs involved in these modes of thinking, then I should at once find myself in the fourth type of thinking. I should be facing a problem whose desired solution would control the resultant process of thinking, including the occurrence of suggestions and the search for evidence which would terminate, if successful, in a more acceptable belief. In the æsthetic situation the problem is to decide whether my feeling of pleasure is merely personal, or points to an objective quality of the scene. In the other case the problem might be to determine the meaning of the words, as, for example, if the language were foreign or the inscription blurred; then

the resulting belief would be one as to the real meaning of those letters on the slab. Or it might be to decide whether the information were reliable or not, and would involve scanning the tablet and its surroundings, and recalling related knowledge already in my possession, for possible signs that it was set up as a mere joke, or were otherwise not to be trusted. The resulting belief in this event would be one as to the correctness or incorrectness of the information contained by the tablet.

Now all this indicates pretty specifically the two major ways in which it would appear possible to improve our thinking, so far as it is subject to improvement. For one thing, we need to devote ourselves to a thorough analysis of this problem-solving type of thinking. For we have seen that thinking which can be right or wrong, correct or incorrect, is thinking occupied in reaching and using a grounded belief about real facts, and it now appears that whenever we are actively engaged in searching for such a belief, or when question has been raised about the adequacy of one already accepted, it is thinking of this sort which takes place. A belief which has been thus actively established or tested always appears in our experience as the solution of a problem, and the reflective process involved is controlled in a definite way by the felt need of attaining the solution. Our question here will accordingly be: *What form does this problem-solving type of thinking naturally tend to take, and in what ways can it be regulated and improved so that the issuing beliefs will be as correct and dependable as possible?*

In the second place, since it is evident that we tend frequently to accept beliefs which come in other ways than as a result of careful reflective thinking, *we need to understand why it is that we do this, and to discover how we can be more alert to question those ideas pressing upon us that are really untrustworthy, and* (since none of us personally has time to investigate everything) *where we can turn for the most dependable information on questions which we have not directly examined.* If we improve our thinking as fully as possible in these two ways it would seem, granted that we are right in

the above considerations, that we shall have done all that we can do to correct the processes by which we accept and use beliefs about real facts in our world.

Is such improvement possible? Well, like every other study, logic assumes that "knowledge is power"—that is, that understanding of the conditions on which any process depends means greater control over the process concerned. If this is the case, then knowledge of the principles of right thinking, by which in the present volume is meant an inquiry along the two general lines just surveyed, ought to issue in improved habits of thinking.

**But why improve our thinking?**

But now why should we try to improve our thinking? Why not continue in our present habits of acceptance and our present methods of solving our difficulties, without going to the labor of securing such improvement as a reflective study of reflection might bring? How important is it, in short, to have correct beliefs rather than incorrect ones, to think rightly rather than wrongly?

The first answer to this question is that in point of fact we do find ourselves from time to time involved in perplexities, and the way in which we as human beings are equipped to meet them is to reflect in the manner above illustrated. And in order to solve these problems in the best manner possible we need to follow the best technique that is possible. How often we make mistakes in our thinking, which we or others subsequently correct but too late to be of help in our original difficulty! How often we reach results which seem satisfactory at the time, but which we later discover to be far less adequate than those we might have reached had our thinking been wiser and more secure! The answer, indeed, is the same as should be given to the question, why ever reflect at all? Did we get into no difficulties, or had we the capacities of an ant rather than those of a man, it would, perhaps, not be necessary to think reflectively, nor valuable to study logic. But being what we are, and living the life we do, there would seem to be no real issue as to the importance of improving our thinking. Moreover, this importance is seen to be the greater as com-

pared with that of other studies, when we note that thinking is involved in all of them, and that, therefore, real improvement in our habits of reflection ought to bear some fruit in increased efficiency in all of our intellectual work. Indeed, one cannot even question the value of a study of reflection without thereby raising a problem which must be solved, if at all, by reflection.

But it is surely unnecessary to multiply words on this point. When we find ourselves caught in an urgent problem, on whose solution our lives and welfare, or those of others, depend, a question as to the value of improved thinking seems quite superfluous. Then nothing else is quite so important as to gain correct beliefs about the facts which thus bear upon us, and our whole conscious energy is absorbed in the effort to secure them. The rescue of the boy in the barrel illustrates this clearly enough. Yet it must be admitted that the question can be given a form which is pertinent and demands a more thorough answer. Granted that we do find ourselves frequently in perplexity, is reflective thinking really our only, or most adequate, means of attack? What are the possible alternatives that Mother Nature has developed? Can it be shown clearly that it would not be wiser to meet these difficulties in which we are plunged, or at least some of them, by some different method than that of reflection, if some other method be psychologically possible? This question we shall face frankly in the following chapter, with the aid of material made available by the modern science of comparative psychology.

Why criticize our beliefs?

Why, also, should we be seriously troubled about the occasional acceptance of an incorrect belief about something? Doubtless we are apt to be satisfied, in situations where urgent practical pressure is absent, with beliefs that turn out in time to have been quite false and undependable. But is this a matter of such great moment? Do not most of these mistaken ideas involve not the slightest difficult consequence? Why, therefore, is it worth our while to acquire such alertness in guarding against their acceptance and in insisting upon their criticism and correction?

Well, it is true that many of our incorrect notions involve no unfortunate results for anybody. The experience with the memorial tablet is a case in point. Suppose there were really indications that the information on the tablet should not be accepted, indications that a critical observation could discover and interpret, while I, through a too trustful habit, failed to notice them and went away believing as true a historical statement that was really false. Here the consequences would surely not be perilous; in fact, I might easily go through the rest of my life without getting into the slightest difficulty through entertaining that false belief. But such is clearly not the case with many of the beliefs which we tend to accept in precisely the same way without reflective testing—that is, on the authority of others.

Suppose we glance at some previous period in human history and see how universally prevalent were beliefs which have now, in all educated circles at least, been relegated to the limbo of superstition. Not many generations ago, in our Western World, for example, it was a practically universal belief that our earth was the astronomical center of the universe, that heavier bodies fell with greater acceleration than light ones, that night air was apt to cause malaria, that people who doubted the prevalent religious ideas were apt to be immoral, that old women who acted queerly were probably trafficking with the devil and should be executed by torture. Almost nobody raised any question about the truth of such notions, but kept on believing them for no more rational reasons than the ones which decided the style of their clothes and the language they spoke. Indeed, it was dangerous even to question them, for one who questioned was himself regarded with suspicion as seeking to upset the very foundations of the life to which society was committed.

But it would hardly be maintained that such ideas as these were not fraught with disastrous results for those whom they affected. To believe in the earth as the center of the universe —still more to believe it flat, as was for most people an accompanying superstition—was to support a whole set of doctrines

which now seem incomparably petty, to forestall the discovery of the laws of dynamics which underlie all of modern applied science, and in particular make impossible the explorations that underlie modern commerce and trade. To believe that heavy bodies fall faster than light ones was to accept a set of notions about physical objects that would, among other things, preclude the invention of the steam engine, the use of electricity, and all the labor-saving appliances which rest on the laws of modern mechanics. To believe that religious conformity should be enforced by law was to accept the principle of the inquisition, and to suppose that old women could traffic with the devil meant to establish and support one of the most horrible persecutions of innocent and helpless folk that the world has ever known. To believe that night air caused malaria was to adopt unhealthy conditions of sleep and to accept a set of medical ideas that made impossible any fruitful attempt to control the plagues by which the world was periodically decimated or to hypothesize any such conception as that of germ-infection, which has revolutionized the efficiency of medicine and for the first time made common diseases controllable in some definite and scientific way.

Fate of the pioneers of science

What a blessing for humanity if these false beliefs could have been discovered and rejected as such earlier! And since there were, even in those dark days, scattered individuals who did realize their falsity and were struggling to establish truer ones, what a blessing if such individuals could have been singled out as the objects of confidence, support, and encouragement, rather than forced to labor not merely in penury, but under the weight of suspicion, hatred, and at times active persecution from those whose welfare was being immeasurably furthered by their work! Is it not a tragic thought that the men whom we at a later time see to have been most deserving of sympathetic understanding and far-reaching influence were little more able in their own day to secure it than the common criminal? The question becomes pressing—and we must endeavor to answer it before engaging on our main task—what are the causes of this tragic blindness? What are the reasons, in human

nature and in the external phases of the situation, that account for the distrust most men have felt for those who were doing most to replace prevalent beliefs which were false, and thus the constant source of misery and death, by those which would be true and thus productive of life, prosperity, and happiness?

But such a question inevitably suggests a pertinent reference to the present as well as to the past. How be sure that we in our day are not also falling prey to this cruel blindness? For as life and change are real, there must be hosts of beliefs which we naturally tend to accept without question, but which will prove in time to have been just as superstitious and productive of harm to us and our fellows as the discarded dogmas which we now look back upon with wonder that people should ever have been silly enough to entertain them. How can we play our part in locating such wrong notions and contribute as fully and rapidly as possible to their replacement by ideas more adequate and dependable? And since no one of us can do more than a small bit of this constructive work individually, where shall we turn for the best available beliefs on which we need practically to act, but which we have not the time or equipment to test personally? Who are the men in our day who in this field or that of human endeavor are most fruitfully solving our problems and furnishing us with the most dependable knowledge to date, and who therefore best deserve our sympathetic appreciation and whole-hearted support? Clearly, only thus can we discriminate intelligently in our conduct between beliefs that have been tested as fully as possible and those that we are apt to accept and base our action upon without careful verification. And it may well be that the gap between the notions of the man in the street today and those of the most enlightened part of our communities is at least as great as that between the abandoned superstitions of the Middle Ages and the convictions of the average intelligent citizen today, and this perhaps precisely on those matters that are of greatest human moment. What attitude ought we to take in the light of these considerations? Is it not vitally important to learn, not only to think as correctly as possible when life thrusts us into

a practical issue which forces us to think, but also to remold our habits so as to deal most helpfully with the mass of beliefs whose truth we tend to assume confidently without testing, and with those situations in which we have to take for granted some beliefs without personal testing?

Summary and outline of Part I

We shall attempt, therefore, in the third chapter to explain the main forces that involve us in fallacious beliefs or lead our reflection into error, and thus hope to make it possible, through understanding our weaknesses and their tragic consequences, to master them as far as we can and to help in reshaping those social institutions which support them. To play our part most intelligently toward the happiness of the world, so far as that can be furthered by thinking about thinking, we need, therefore, a preliminary study, which will occupy us in the two ensuing chapters. One will take the form of a study of reflection in the light of the available alternative ways of meeting perplexities, the other of the factors which hinder right thinking and those by whose aid we may hope to establish attitudes more favorable to correct beliefs and clear thinking about the facts on which human happiness depends.

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## CHAPTER TWO

# REFLECTIVE THINKING AND ITS ALTERNATIVES

Reflection a form of learning

IS REFLECTIVE thinking the best way which nature has provided for meeting any perplexity?

The first point to note here is that thinking of the sort which aims at the solution of a perplexity is a form of what we call (in common language and also in technical psychological terms) *learning*—that is, it is a way of adapting oneself to a situation which in some respects is novel. To realize this we need only observe that no perplexity arises when we are in a situation to which nature has equipped us with a suitable instinctive response,[1] as when we reach for food if hungry and it is placed before us; nor when we are in such a familiar situation that previously acquired habits enable us to meet its demands without conscious effort, as when we grasp in conversation the meaning of a common word. It is when we face something to which we have not become adapted in these ways, and to which we feel the need of adaptation, that we find ourselves in a perplexity, and our available resources are mobilized under the guidance of the desired solution. Much of our day's routine, such as arising, performing our toilet, dressing, etc., is performed by instinct and habit without conscious attention; it is when some question arises due to the difference between this day's demands and those of previous days, such as new lessons assigned, new engagements to be met, and the like, that active reflection appears, determined in its character by these novel demands. Otherwise our thinking would all consist merely in otiose reveries or appreciative absorptions, and it may well

[1] Instinct seems still the most generally accepted term for modes of behavior to which we have an original predisposition. They do not need to be acquired, but form our given capital of response.

be doubted whether we should even be able to engage in these idle performances in any definite, recognizable way. Now we all know that other animals than ourselves are able to learn, in this specific sense of adaptation to the novel, and psychology has revealed pretty clearly the nature of the process as their efforts exhibit it. The phrase "reflective thinking" describes this learning process as it appears in the most complex adaptations of human experience; we shall compare and contrast it with the animal learning which preceded it in the course of evolution, and which we also have to fall back upon when reflection fails. Psychologists have described this form of learning by the phrase *trial and error,* a phrase descriptively rather unhappy for reasons which we shall soon see. Robinson has suggested a much more suitable description under the term *fumble and success,* and this is the phrase we shall adopt in the present volume.

### A. THE METHOD OF LEARNING BY FUMBLE AND SUCCESS

Inorganic adaptation

If we wished to extend the idea of learning in a manner which would be very illuminating in some directions, though rather confusing in others, we could say that even inorganic objects learn, for they, too, in a sense adapt themselves to situations in which they have not previously existed, and the changes thus produced in them will be retained as long as they remain in the new environment. Thus, bring a small piece of iron near a powerful magnet, and its behavior will change in response to the demands of its new neighbor; or put it in a place where dampness is constant, and it will gradually adapt itself by turning into a pile of rust. But such changes are different from the learning of an organism in a very fundamental respect. It is quite obvious that the iron (if we use a little animistic phraseology) is quite willing to become something else than iron if the laws of the new situation so require; as the second illustration in particular shows, it would just as soon become rust as remain iron. That is, it will adapt itself by dying just as readily as by continuing to live. The learning of an organism, on the other hand, consists precisely in the

effort to maintain and expand, in face of a novel situation, the characteristic pattern of activity which makes it the kind of creature it is. The adaptation is active rather than passive; there is an insistence that, if possible, the novelty shall be assimilated in such a way that the life of the organism (by which we mean its pattern of behavior) be preserved and furthered.

**What organic learning involves**

It is evident that for a creature to be able to learn in this way it must be equipped on the negative side to drop off a response to a stimulus when the latter becomes harmless, or one which in a new situation brings harm rather than benefit; and on the positive side to bring into play further responses to a difficulty when the first response made fails to extricate the creature from it. We shall find that the various organisms differ from one another fundamentally in the number, complexity, and relevance of these possible responses, the rapidity with which they can be brought into use in a perplexity, and the degree of permanence with which such acquired adaptations can be maintained.

**Simple fumble and success learning in the amœba**

Let us bring out this distinction first by examining learning in the *amœba,* a single-celled microscopic creature in whose behavior the method of fumble and success learning is revealed in a very simple form. So far as experiments to date have revealed, this minute animal is equipped to perform only five different reactions, simple locomotion, ingestion of food, an approaching reaction, an avoiding reaction, and a reaction calculated to bring it into its normal attachment to a solid object when by chance it is floating free in the water. Furthermore, each of these reactions has to be performed in a fairly fixed manner, though some minor variations are possible in their performance in different situations. Now put the amœba in a somewhat new environment, and how will the little animal attempt to adapt itself? In the first place, it is able to get used to some conditions which would naturally stimulate the avoiding reaction; if the continued stimulus proves to be not harmful, the reaction is dropped. Thus amœbæ, it has been found, naturally react negatively to tap-water or to water from a foreign culture, but after they have been transferred to such water they

behave normally. In the second place, the avoiding reaction itself, which is the one usually depended on by the animal to extricate it from difficulties, reveals a few variations that can be successively exercised if need arise. Thus, "if an amœba comes into strong contact with a solid obstacle in its movements, or if a solution of different composition from the water in which it lives strikes against it, or if one side of it is heated, the animal responds by contracting the part stimulated, releasing it from the substratum (on which it is crawling), and moving in another direction, usually one forming only a small angle with the preceding one." But now increase the stimulus so that the whole side or end of the animal is affected. Then "the side stimulated contracts as a whole, and the movement takes place in the opposite direction." [1] It is clearly of great advantage to the amœba to possess even this limited variability of the avoiding reaction, for while it does not need to retrace its motion on account of every difficulty met (if the latter is not severe it can explore in a new direction), yet if the danger is great it is able to return by the route which has already been found to be safe. But, in the third place, neither the positive nor the negative lesson thus learned can be retained. Take the amœba out of the tap-water and place it in its normal culture again, and in a short time it will react negatively to tap-water as it had done before being transferred to it. And if an object which required the retracing form of avoidance is again used as a slight stimulus, the simpler negative reaction is again first given, showing that the animal is unable to retain the effects of the previous experience.[2]

That some retention is possible, however, even in the simplest creatures, is shown by interesting experiments on the paramœcium, a unicellular animal like the amœba, but equipped with

[1] Washburn, *The Animal Mind*, p. 40f.

[2] So far as experiments show, the effects of adaptation to novel stimuli are quickly lost even when we rise much higher in the scale of evolution than the unicellular animals. The sea-anemone *actinia*, for example, can learn after a few trials to distinguish between real food and filter-paper soaked in food-juice, but if not experimented on for six to ten days all traces of the learning are lost.

hair-like cilia on its sides, by whose wave-like motion it swims through the water, and a rudimentary mouth.[1]

In these experiments it was found, not only that the paramœcium is able under repeated failure of its normal response to bring into play a quite unusual one (bending double in a narrow tube), but also that the number of unsuccessful trials of the normal response decreases in successive experiments until the successful response occurs almost at once. This is typical of learning in much higher animals, such as rats, cats, and dogs, and shows that in a later experiment there is some retention of the effects of the earlier ones. But all that we know about such simple organisms as paramœcium goes to show that if the experiments had not been practically continuous there would have been no such retention, whereas, as we shall see, fairly permanent retention is possible in the case of many higher animals.

We shall now repeat accounts of experiments only for the purpose of illustrating important further stages in the development of this learning process. The essential point to remember is that as we advance in the evolutionary scale, the number of different responses that can be brought into play to solve a

[1] The normal avoiding reaction of paramœcium is to back off from an obstacle, roll over, and swim forward again at a small angle from its original direction. The experiments in question are described as follows by Washburn (*Op. cit.*, p. 262).

"A glass tube was drawn out until it was so fine that not more than one paramœcium could get through it. This tube was filled with water up to a certain point, and a single paramœcium, carefully isolated for identification throughout the experiment, was allowed to swim up the tube until the surface film was reached. The animal behaved towards the film as to any mechanical stimulus, darting backward, rolling over towards the side away from the mouth, and swimming forward again. Since the tube was so narrow, this method, which ordinarily succeeds in avoiding obstacles, brought the animal against the surface film again. After repeatedly going through the same performance, the paramœcium varied its response and succeeded in turning completely around in the tube by bending its body double. On being put again into the same predicament, it gradually diminished the number of trials of the unsuccessful negative response, and arrived at the point where it almost immediately doubled over on striking the surface film. The observations established the existence of a relatively high type of learning in the simplest group of animals."

perplexity, and the rapidity with which they can be resorted to increases, while their relevance also seems to be improved, and through enlarging ability of retention the results of the learning are made more surely available for the future.[1]

**Learning in the higher animals**

The gradual dropping off of useless movements and the organization of successful responses into relatively permanent habit-systems, is revealed in the mastery of puzzles of considerable complexity by such animals as rats, cats, dogs, birds, and, with a somewhat higher degree of ability still, raccoons and monkeys. Thorndike's work on cats and dogs is typical of such experiments. The animals were placed in boxes, with food on the outside, the construction being so arranged that they could get out by pulling a wire, clawing a button, pulling a string, raising a thumb-latch, or in some other such fashion. At first they responded by all sorts of random clawings and bitings at different parts of the box; the successful movement was hit upon only by accident. On being replaced in the box the useless movements became fewer in number. The animals tended to concentrate on the part of the box which was associated with success and the time wasted was much short-

[1] Experiments on the starfish and the stentor reveal learning ability intermediate in degree between that shown by the unicellular animals just considered and that possessed by such higher animals as cats and dogs. Preyer "slipped a piece of rubber tubing over the middle part of one of the arms of a starfish belonging to a species in which those members are very slender, and found that the animal tried successively various devices to get rid of the foreign body, to wit, the following: rubbing it off against the ground, shaking it off by holding the arm aloft and waving it pendulum-wise in the air, holding the tube against the ground with a neighboring arm and pulling the afflicted arm out, pressing other arms against the tube and pushing it off, and finally as a last resort, amputating the arm" (Washburn, *op. cit.*, p. 247f). The ciliate stentor, when persistently stimulated by a foreign substance, shows still more clearly the tendency to proceed to more and more violent methods of avoidance as the less radical ones prove a failure. It will first simply bend over to one side, then reverse the direction of its ciliary action, then contract vigorously upon its stem, and finally, if the stimulus continues and none of these responses proves successful, it will break from its moorings and swim away. In all the cases so far noted the general fact is that the later response involves a more violent change of the ordinary life-course of the animal than the preceding one, and is only resorted to when the simpler modifications prove inadequate.

ened. As the experiment was repeated again and again, more of the useless movements were omitted, until finally the right one was performed unerringly as soon as the creature was fastened in. In the case of cats, in general, about fifteen to twenty trials were required for this stage of prompt and certain response to be reached. Other experimenters have found that monkeys are able to master, by the same process, very complicated combinations of fastenings which have to be dealt with in a certain order, running sometimes up to nine or more in number. In problems of this sort raccoons show ability intermediate between that of cats and that of monkeys.

Here we have a prime example, at a high point of development, of the fumble and success method of learning, and the pertinence of the phrase to describe the process is evident. The animal fumbles around with its various possible responses, trying first those which upset the ordinary course of its activities least, until one of them succeeds in extricating it from its difficulty or else it finally succumbs to the situation. Since success it is which fixes the final response and makes it possible to eliminate, in later trials, the useless movements, it is important to include it in the descriptive phrase, even though it must not be taken to imply that complete success is sooner or later always achieved. Of course it is not; animals (including human beings) fall into many dangerous situations with which their adaptive powers are unable to cope; then the method of inorganic adaptation is the only one left, and it never fails. But that many organisms do survive and develop in a changed environment is evident.

Survival value of more efficient learning

Now it is clear that the ability of an animal to surmount such complex obstacles as we have just observed, in its pursuit of food or escape from danger, is of tremendous survival value. Of course in the experiments plenty of time was given for the creature to show what it could do, and it would not have starved had it failed entirely to solve its puzzle, both of which alleviating conditions would not always be true in nature; yet the tests do show what success under favorable circumstances or by happy accident a creature in its natural habitat might

be able to achieve in avoiding novel dangers, and are typical of what must be going on all the time with less secure results. *And the main lesson is that every appearance, in the course of evolution, of a variation which enables this sort of learning to be achieved more efficiently, gives its possessor a distinct advantage in competition with its less favored fellows.* Other things being equal, it will be able to master better than they the problems which changed surroundings cause, and will thus be more likely to survive and propagate offspring which, varying around the parent stem, will be more apt to be like it than like its supplanted rivals. To be able more readily to drop off responses to stimuli that are no longer beneficial or have become positively harmful is an advantage because it frees the attention and energy of the creature from the necessity of further preoccupation with them, and enables it to concentrate its responses on the stimuli which are now most important in furthering its welfare. To win a high degree of permanence in the effects of the learning performed is to be able to identify repetitions of situations that have been earlier controlled, and at once respond appropriately to them, thus avoiding the effort of learning the same lesson twice and the loss of time that might be used in responding to other demands and opportunities. And of course the capacity to bring into play a greater variety of movements gives its possessor further chances of life and satisfaction after its competitors have exhausted their repertoire and found none of their responses quite adequate. Granting the general presuppositions of the theory of evolution and the appearance in nature of such variations as these, and the gradual production of creatures with greater and greater learning power is seen to be inevitable.

**Inadequacy of fumble and success learning**

In fact, in a broad sense, as we shall see, the method of fumble and success learning is quite all-inclusive and universal, the most brilliant example of scientific genius or philosophical insight being merely an illustration of it at its highest level. Yet it is important to distinguish the form which it reveals in the instances so far discussed from types of learning to which we must now proceed. To that end we must note the

fundamental inadequacy of fumble and success learning of the above sort. This is the fact that such learning is essentially individualistic—that is, its results accrue only to the animal who has achieved the lesson by its own fumbling responses, and cannot be made available to others except so far as they, too, go through the same lengthy and difficult process. Thus at this level of biological development nature is able to advance only by the tortuous means of providing that the offspring of possessors of favorable variations, such as a readier learning capacity, shall be apt to possess similar capacities—there is no way, so far as our knowledge at present indicates, by which they can acquire directly the helpful lessons so painfully achieved by their parents. The latter are quite lost when the one that has learned them dies. In the light of this inadequacy we see at once that when such a variation should appear as would make possible a social spread, so to speak, of the results of learning—enable one individual to appropriate directly the beneficial lessons won by another, and in particular enable a new generation to start its struggle with some of the capital acquired in the experience of its parents—the race so favored would have an enormous advantage over even the best of those whose capacity of learning was limited to the amount that could be gained in an individual's lifetime. For racial variations would continue to appear in its case as well as in theirs. We see, of course, that this is exactly what has happened in the case of human beings at least, and we must therefore turn now to a type of learning sufficiently different from what has just been described to deserve another name. We shall call it

### B. LEARNING BY IMITATION

Importance of the distance senses

First, however, we must consider a matter that might at first sight appear irrelevant to the present theme.

One of the most interesting differences between animals low in the evolutionary scale and those more advanced lies in the fact that the latter are able to respond to objects at a much greater distance from the body than the former. The dog, for

example, barks at the moon, which is far enough away to be beyond the reach of his practical concerns, while we do not have to descend to the simplest creatures to reach organisms that are unable to respond to objects more than a few feet away. This aspect of the evolutionary advance is of course conditioned by the development of the distance senses—those of sight, hearing, and smell—and psychologists are in great doubt as to just how early these appear, the perplexity being particularly serious in the case of hearing. Sight is pretty clearly present as low as the cœlenterates, and much evidence strongly suggests that all animals are able to respond by something definitely analogous to our sense of smell. Apparently no creature is limited to contact responses alone, even the single-celled amœba being found by Jennings to respond to light beams that passed no nearer its body than one-eighth of an inch, but the perceptive range of many of these rudimentary creatures is very meager.

Now the survival value of ability to respond to food or danger when it is still at a greater distance from the body than the responses of one's rival can carry is too evident to need comment. But our chief interest in the development of such powers of response, lies in the way in which it makes possible what we call *observation,* whose effects are somehow preserved by the organism, and whose function in expanding powers of learning becomes very important.

Value of observation and memory

Learning by the fumble and success method as outlined above is essentially learning *by doing* rather than by observing. Put the animal in a perplexing situation, and instead of surveying his fix he at once begins to do something. He is too impulsive to observe, he must bring into play his overt responses one after another, till the successful movement happens to be made. But a creature in whom efficient distance receptors have been developed frequently finds himself in situations in which immediate response by muscular action to a thing seen or heard is not needed. In fact it may be better warily to watch a distant enemy for a time rather than seek escape at once, or to ambush intended prey (especially if it is fleet of foot or wing)

instead of blundering after it without delay. Given such conditions, a favorable variation in animals with good distance receptors would be the tendency to inhibit direct muscular response in favor of further auditory, olfactory, or visual exploration of the object. Thus we can understand in evolutionary terms some of the most interesting, as well as familiar behavior of the higher animals (who has not watched a cat stalk a bird?), and at the same time we have a kind of response which is the root of the two processes in terms of which further advance in learning ability takes place—analysis and imitation.

It is clear that with behavior of this sort functioning, it would also be advantageous to possess the ability of retaining and recalling, on appropriate occasion, some deposit of the exploratory observations thus made when overt action was restrained, in fact it might be necessary for some rudimentary retention of this sort to coöperate in the development of observation from the start. At any rate there is clear evidence of the appearance and gradual development of some inner deposit of past observation that fills the same function that memory-images do in ourselves.[1]

[1] One of the experiments that contribute heavily to such evidence is known as the *delayed reaction* experiment. Hunter, for example, placed various animals before a row of three food boxes, all looking just alike, two of them, however, being locked, while the third was unlocked. Sometimes one was unlocked and sometimes another, but at any given time the unlocked box was designated by an electric bulb lighted above the door. Then the animals were trained to go to whichever box showed the light; they always got food from the lighted box only, and the learning was a simple example of the fumble and success method. When they had thoroughly learned this lesson, the delayed reaction experiment began. In this the animal is held while the light is burning, and only released a certain time after the light is out, the problem being whether after this delay he will still be able to follow the signal and go straight to the right door. The result of such experiments was that all the animals could do so, provided the delay was not too long—how long it might be depended on the animal. With rats the delay could not much exceed five seconds, with cats it could reach eighteen seconds, with raccoons thirty-five, with dogs one to five minutes, with children it increased from twenty seconds at the age of fifteen months to nearly a minute at two and a half years, and to twenty minutes or more at five years. But the most instructive lesson for our purposes was that the rats and cats, besides requiring a briefer delay if their orientation was not to be lost, needed also to have their heads

Now it is easy to see that in animals able thus to preserve the effects of past observation, a tendency might soon appear to imitate an observed act as performed by another animal, without going through the process of learning needed by the latter in order to acquire it—provided that their attention is really caught by the performance and that the elements of the act are ones with which they are already familiar, so that the observation may arouse in them the appropriate muscular responses.

Imitation in the chimpanzee

Such imitation, under very favorable conditions, has been experimentally established now in the case of the chimpanzee. This animal is far and away the most intelligent member of his genus, which is itself the most intelligent family of creatures outside of man. If two cats are taken, one having mastered a certain puzzle box and the other not, and the former is made to show his trick before the eyes of the latter, no benefit seems to have been derived from the observation at all, which shows that observation in the proper sense has really not taken place. When the second cat is placed in the puzzle box, he has to go through the process of fumble and success learning like the first one; he does not even learn any quicker than if he had not seen the other cat at all. With chimpanzees, however (and perhaps with exceptional animals of some other species, too, though in their case the evidence is not so clear), the

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or bodies kept turned toward the right box during the interval between the signal and the release; otherwise they could not respond properly. This means that it is possible to explain their behavior by sustained attention, without appealing to anything of the nature of a memory-deposit to guide the reaction. The raccoons, however, and children, sometimes also dogs, were able to react correctly even though they shifted their position and attention during the interval. Now in ourselves we should explain this fact by the functioning of a memory-image or idea as directing the response after the interval of attention to other objects, and it is clear that some inner orientation fulfilling the same purpose was present in these animals. In speaking, for example, of the performance of the raccoons in his experiment, Hunter says, "Each of these animals could react successfully when the wrong orientation was held at the moment of release, and when, so far as the experimenter could detect, no part of the animal's body remained constant during the interval of delay" (Quoted in Washburn, *op. cit.*, p. 297).

matter is otherwise. Such experiments as the following are typical.

An experimenter having taught one chimpanzee to extract a banana from a long tube by pushing it out of the farther end with a stick, the animal was made to perform before another chimpanzee who watched his actions closely. Then the first animal was taken away and the second put in the same situation. At once he took the stick, poked it into the tube, and after some fumbling managed to get the banana, though he did not imitate the action of his fellow exactly, but pulled the banana toward him in the tube till he could reach it. Haggerty secured many similar results by experimenting on the monkeys in the Bronx Zoo. One monkey, for example, was allowed to watch another climb several times up the side of the cage, thrust his arm up inside a wooden chute, and pull a string, as a result of which food came tumbling down. On being given a chance himself, he first looked about over the floor for food, and then climbed the front of the cage, stopping on the brace opposite the chute. "He leaned over to the chute, and while still standing on the brace with his feet, tried to thrust a hand into the bottom of the chute. Failing in this, he ran along the brace . . . and back again to opposite the chute; catching the rung of the chute in his hands he drew himself over to it; finding himself above the end of the chute, he tried to let his body down, first on one side and then on the other, until in the most awkward manner he managed to get near enough to the end to thrust a hand up inside far enough to reach the string. At once he pulled, and the food came tumbling down." (*Op. cit.* p. 297.) The writer made some brief experiments on a highly intelligent young chimpanzee in the Lincoln Park Zoo, which seemed to indicate that the animal was able to imitate human beings with much the same degree of success as is shown in imitating his fellows. A banana was given him in a bottle with a screw cover, which he attempted to extricate by the fumble and success method. He occasionally located the cover as needing special attention, but showed no disposition to turn it. The experimenter then took the bottle, unscrewed the cover before him,

and emptied the banana out—it was then replaced as before and given back to the animal. At once he grasped the cover and turned it though without further help he did not show the persistence needed to turn it far enough. This was perhaps due to the fact that he was not very hungry.

Such experiments as these seem to indicate that the chimpanzee is able to learn by the method of imitation, at least to the extent of being guided by some inner deposit of his observation of another's performance (or position at the time of performance) to the right location or part of an object to be dealt with, and to the right general type of movement to be performed. Though it is greatly shortened, the element of active fumble and success is not entirely eliminated, and a definite gap remains between this method and that of reflective thinking, with which we shall soon compare it.

Human beings recapitulate the learning stages of the race

It is instructive to note how in their individual growth human beings recapitulate the learning stages shown in the development of the race. The baby begins to learn by the method of active fumble and success solely. In this way his most fundamental adaptations are gained, such as control of his eyes, hands, head, and feet, so that he can move them at will in a definite way, and simple manipulations of objects that he can grasp or push. Before he is many months old some imitation of the movements of others can be noticed. He begins to repeat words which he hears them speak, showing ability to coördinate the motion of tongue, lips, and vocal chords, by observation of their performance. By the time children are two or three years old they are able to learn most of what they learn by the method of observation and imitation, supplemented, of course, by continued active fumbling. At this age the normal child's intelligence is fully equal to that of the chimpanzee, and from this time on he is frequently to be found controlling his actions in various ways and with increasing degrees of success by what he has observed his elders do. The little boy sees his father mend a box, and soon you will find him pounding with hammer and nails for himself. The girl watches her mother go through the daily routine of caring for the baby, and soon her dolly

becomes the recipient of the same treatment. The child's acquisition of language is an especially interesting illustration of this method of learning, and is fundamental for its intellectual advance in other ways. No one who has lived with young children can doubt that while their learning to talk involves much vocal fumbling, observation of the speech of others is a constant and indispensable guide; indeed, without it a definite language could hardly be transmitted from generation to generation.

Value of the method of observation and imitation

Now the great advantage of ability to learn by observation in this way has already been pointed out by anticipation. It makes socially available the beneficial results of individual learning, and thus for the first time makes the building of civilization possible. At the level of fumble and success learning merely, the only advantage one generation has over its predecessor lies in the possible possession, here and there, of a slightly more favorable variation, such as ability to make an additional response, or a nervous system organized to preserve better the effects of previous action. Where imitation is possible, the advantage is enormously reinforced by the power to preserve the successful lessons gained through the individual experience of members of the preceding generation. Education appears for the first time, and becomes the most important social institution, since in its most common sense it consists precisely in the transmission to the young by the old of the accumulated intellectual capital of racial experience. Before this, the only happy inventions which can persist are those of nature herself in the richer capacities of individuals which she produces. Now, inventions in the form of external material things such as tools, and growing institutions of social life such as language, art, and religion, can be passed on from age to age and developed through the living experience of successive generations. It is this accumulating mass of visible and invisible social capital that we mean by the term "civilization."

Obviously, a race which is able to use learning of this sort constantly and on a large scale will accelerate enormously its adaptation to the conditions of life and happiness, and will soon

establish itself securely against all competitive species. A given generation will no longer be forced to spend practically all of its time acquiring the same degree of skill possessed by its predecessor; this it will master fairly early in life and without serious risks, and the rest of its energy will be released to see possibilities of improvement hitherto undreamed of, and to win a still higher degree of control over its environment. Man was fortunate enough to be the first species to appear, equipped with this capacity sufficiently strongly and universally as to outstrip all his competitors in the biological race; and now he is so far ahead, and is able to control all of them so completely, that the scattered similar abilities of some of them will never gain for them what man has achieved. Even chimpanzees do not educate their young in the human sense, nor have they built civilization. This shows that whatever their powers of imitation under favorable conditions, in their natural habitat these have been exercised too slowly and meagerly for them to become a rival of man in gaining dominion over the world.[1] Nor have the insects—some species of which, such as ants and bees, have established a high degree of institutional organization by developing social reflexes rather than observation and imitation—won the flexibility thereby which could render their intelligence comparable in effectiveness and further adaptability to that of man.

Why imitation is inadequate

We must now note, in turn, the essential inadequacy of learning by observation and imitation, however great its advantages over mere fumble and success learning.

Consider the following experiment on an intelligent chimpanzee. The animal having mastered, in about three trials, the problem of opening the door of a puzzle box by turning a button, a second button was put on a few inches from the first, both being exactly alike and operating in the same way. Any normal human being, of course—even a child of a few years—would have at once responded appropriately to this

[1] See Hobhouse, *Mind in Evolution,* and Kohler, *The Mentality of Apes,* for further information on this head. Kohler records the most recent experiments.

situation by turning both buttons. What did the chimpanzee do? He paid no attention to the second button, but turned the first one as before, and when the door failed to open he kept on turning the first button back and forth and tugging at the door. After a time, he did shift to the second button and turned it, but, as he had left the first one closed, the manipulation of the second was of no use. It was a long, hard job, resembling essentially the fumble and success method, for him to learn to operate both buttons correctly, and the experiment showed that he did not see into the principle of the relation of the door to the button, but was guided mainly by the observation that the button was the place and the kind of thing to work with in trying to open the door. Indeed, the observation of *place* was the most important, for at one time, in order to force him to deal with the second button, the first was removed, but he still showed a tendency to finger about the place where it had been.

This experiment shows that it is possible to observe, and profit in future action by the observance, without (as we say) seeing into the principle of the thing and thus being able to transfer readily the lesson learned to another situation involving the same principle in a different form. The deposit of the first situation is carried over bodily to the second, about the only analysis made being a rough spatial one of what part of the situation to attack, together with the relation between it as thus differentiated and the kinæsthetic sensation of the appropriate muscular movement. The chimpanzee would doubtless have been able easily to open a second box constructed like the first, but a second button on the same box was very confusing and could be mastered only by continued fumbling. Suppose, however, creatures should appear whose memory-deposits as well as observations included a much more thorough and definite analysis of the situation, that is, a breaking of it up into its various parts, qualitative as well as spatial, and a noting of the way in which each of the various parts functions in the whole as the successful movement is attained. That is, suppose we have a type of observation that develops and is preserved in

memory, not merely in bulk, but including precise discriminations of parts in their functional relation to the whole and to the desired end. Such a creature will be able to transfer a lesson learned in one situation to any other situation which contains any elements similar to those noted in the earlier, and will be able to anticipate what function they will perform under the conditions he can apply. He will not merely remember a gross fact of prior experience, together, perhaps, with a localization of the place in it that was dealt with successfully; he will remember that the door opened when the button was turned, not when a certain place was manipulated. But such a creature will be learning by

### C. THE METHOD OF REFLECTIVE THINKING

Reflection and fumble and success learning

It was remarked earlier in the chapter that the method of learning by fumble and success was in a sense all-inclusive, every form of adaptation through individual experience being in some way properly describable by that phrase. We are now ready to expand this statement. The learning so far described under the head of fumble and success is learning through *doing;* that is, only by continued individual performance of the activity involved does the animal's nervous discharge gradually avoid the useless fumblings and open at once a free path to the successful movement. The difficulty can be solved and the solution made permanent only by this gradual process of repeated muscular activity in the perplexing situation. Learning by imitation is the method of fumble and success through *observation* of the performance of another, and the coördination of what is observed with one's own muscular control. Something is carried over from the observation—perhaps an image, at least incipient movements of the muscles involved—and the fumbling is one of securing the right relation between what is thus carried over and complete overt performance when the observing animal is placed in the same situation. Learning by reflection also involves a definite element of fumbling, without which it could not take place; it is the method of fumble and success through

abstract analysis and synthesis. In the first chapter this process was described in a general way for the purpose of identifying it in contrast with other types of human thinking. Let us now try to describe it in terms which shall reveal as clearly as possible its relation to the forms of learning with which we have now become acquainted.

**Reflective analysis and synthesis**

What happens when an individual capable of reflection finds himself in a perplexing situation? Let us again take a concrete example.

Suppose a human being of ordinary ability and range of experience wakes up in a strange room. The strangeness being unpleasant, he wants to get out and get home. So he rubs his eyes, sits up, and begins to explore—that is, as we have said, to analyze, to break up the situation into parts. Stone walls—and at once the suggestion comes, fruit of a memory-idea of the behavior of stone walls in the past—no use doing anything with them. Analysis continues, the whole process being far more rapid than the description can be made to indicate. A window—iron bars around it fastened in the stone—no use doing anything there, either. A door in the wall—and now attention concentrates, because doors have commonly been found to be the way out of rooms, and the suggestion therefore is of peculiar vividness that something to be done to the door will be most likely to succeed. (Note that this is about as far as the animal who learns merely by observing and doing seems able to get—some *place* in a general situation where action is especially demanded.) The man walks over to the door to observe it better, and analysis is now concentrated upon it. No latch, knob, or lock in the usual position. Further scanning. Ah! something similar to a bolt at the top of the door. Suggestion—unfasten that, then (consequences imaged in terms of previous experience of the relations of bolts to doors) the door will probably open. This is sufficiently promising to allow discharge into overt action. A pull at the bolt. It fails to give. Soon it slowly gives, but springs back when pressure is relaxed. Now imaginative synthesis begins to coöperate with analysis. Some way must be found to pull at the door and hold the bolt

down at the same time. If that can be done, the door will open. Suggestion—hold the bolt down with one hand while pushing at the wall beside the door with the other. This, too, is promising enough to lead to overt action. He acts accordingly, and with a hard push the door opens. And since we are not beginning a novel, let us not plunge our hero into further exciting adventures, but suppose that he meets at the door nothing more disturbing than an experimental psychologist with a stop-watch in his hand, who has been observing his behavior through a hidden opening and measuring the time required for his escape.

In such a typical reflective performance it is clear that the essential factor which is not found in learning by mere doing or mere imitation, is the ability to observe and remember by a process of definite analysis, and to combine (which is what we mean by imagination) the elements thus analyzed out in various ways. Fumbling is as surely present as in any other method of learning, but a large share of it is transferred from the field of overt action to that of memory and imagination—only when that mental process of analysis and synthesis has gone far enough to bring forth a suggestion which in the light of the dissected past experience thus mobilized gives promise of success, does overt action to solve the difficulty occur. If such action fails, the same process continues in the light of the lesson revealed by the failure, till either a successful suggestion is found or the attempt to solve the problem is abandoned. But it was because the man was not only familiar with rooms in general, but also with stone walls, iron rods, doors, latches, bolts, and their functional relations, and was able to recall and combine these according to need, that fumble and success could be largely transferred to this imaginative realm. Definite analysis and ordered synthesis are therefore fundamental.

Just what is the significance of each of these processes? Let us see. The perplexed reflective thinker first observes the situation to get his bearings, noting the various elements which can be distinguished within it, and attending to them separately. What is the use of this? The answer is, in the first place, that

if the situation as a whole were similar to one to which he is already adapted it would not be perplexing—he would react at once in the appropriate way. In the second place, since the situation as a whole is different from anything previously faced, it is helpful to discover parts of it which are not different, in order that one's previous experience of their ways of behaving may be utilized for present guidance. And in fact, as the situation is thus analytically scanned, suggestions occur of what one should do to solve the problem. What are these, and where do they come from? They are simply ways of acting that in the past have been successful in getting us out of difficulties which in this or that respect were like the present difficulty, recalled in the form of memory-ideas, and combined by the imagination so as to become as relevant as possible to the different ways in which these familiar elements are now combined. This process of constructive imagination is guided by further memory-ideas of the consequences of the suggested actions as they had previously functioned, until finally a complex suggestion emerges whose anticipated consequences in the light of past experience sufficiently correspond to all the relevant elements in the present situation to induce us to act upon it. The fumbling is therefore one of qualitative analysis and synthesis through the aid of memory and imagination, and overt action is only engaged upon when this process has brought clearly to bear upon the problem the accumulations of past experience as dissected and related in relevant ways.

**Advantage of reflective learning**

Now the advantage of being able to learn in this way hardly needs to be elaborated. It saves time and energy, and it does not stake the individual's life or welfare on each suggestion in succession as overt action would often do. It saves time, because memory and imagination are far quicker than physical action. They can resurrect a prior experience with this or that object and follow it through to its observed consequences in a minute fraction of the time which the actual suggested manipulation of it would require. It is for this reason that the possession of such ability enables its possessor to anticipate future events and prepare for them while they are taking their own

time to arrive. It avoids much danger, because oftentimes serious consequences are staked on the overt performance of a suggestion, and if it be possible to anticipate such consequences in imagination and select for action suggestions in the order in which they are most likely to be successful, much dangerous trying out of other possibilities is avoided. A child lost near dusk in a deep wood, for example, will not be able to commit himself to action in many ways before he will be in serious danger, and it would be highly dangerous in any case to try a path which really led farther from safety. Ability to analyze, to bring forth relevant suggestions and foresee their consequences, would there be of the highest value. *We thus see that learning by reflective thinking is by far the most efficient and advantageous method of learning that has so far appeared in the course of evolution. Since it contains the possibilities of the earlier methods and this highly advantageous power of analysis and constructive imagination in addition, its possessor has an enormous opportunity to outrun all competitors in securing whatever ends he desires to attain, whether life, prosperity, service of his fellows, or other goods, and any variation which enables this process to be performed more effectively will, other things being equal, be of greater evolutionary value.* For he is not only better able to adapt himself to the play of environing nature, he is also better able to adapt himself to what his fellow-learners are likely to do than they are to adapt themselves to him. Reflection is not infallible, of course. There is no guaranty that in the case of any given perplexity a saving solution will be forthcoming. Wherever there is an element of fumble, success is not sure. But compared with other methods reflection is more sure. It brings to bear, in the most effective way that is possible at any given time, the relevant lessons acquired from past experiences similar to the present perplexity in this or that significant respect.

Should we then, in preference to reflection, attempt to meet a difficulty, whatever it might be, with a mere guess, hunch, intuition, or uncriticized suggestion from some one else? These are the popular alternatives, in human practice, to the method

of reflection. Just what is their nature and significance in the light of the above discussion? Well, is it not clear that the first three constitute a reversion to the method of overt fumbling —commitment to a suggested action without imaginative criticism and comparison with other possible alternatives? And the fourth is a form of learning by sheer imitation of others' behavior. In many situations, of course, we have to do something like this, in lack of past experience of our own that is similar enough to offer relevant material for reflective imagination to operate upon. But to do this when reflection is possible is to turn to mere chance when more definite guidance is available, and to defend such procedure as an adequate general technique of ordering one's life is surely the height of irrationality. Does not the above excursion into comparative psychology indicate clearly that in every puzzling situation the reflective method includes all that other methods can offer, and adds to that the fullest guidance that experience of related situations affords?

This is the answer in general terms, by a study of its evolution, of our question in chapter one concerning the importance of the reflective type of thinking, in relation to alternative ways of meeting perplexities, and the supreme desirability of improving its performance.

Place of language in reflective analysis

There is another question, however, which it will be most helpful to discuss in the present context. What sort of procedure is this abstract analysis which we have found the key to the special nature of reflection as a form of learning, and what are the main conditions of its development?

We shall approach the first part of this question by way of the second. And the needed answer for our present purpose will be twofold: on the side of the physiological mechanism and the social institution involved, the main condition of reflective analysis is *language;* on the side of the psychological motive required, it is *curiosity.*

To analyze an object so as to bring out its elements clearly, hold fast the way in which they are related and combined in the situation at hand, and be prepared to recognize them in new situations, must be a practically impossible process until

language is also developed to the point where definite symbols can be readily applied to them. At any rate, the perfection of a system of names whereby they can be recorded, along with the making of further distinctions, greatly hastened the evolution of analysis, and the imitation of one creature's cries by others, in face of objects of common interest, made the qualities thus brought out and responded to a fully social possession. For this, of course, it was necessary to command a large variety of vocal sounds, and the process becomes one of fixing a perceived quality by attaching its occurrence to a definite vocal movement, audible to whoever happens to be within hearing range.

It is beyond our province to elaborate any theory as to how all this takes place in detail—on many questions, indeed, there is as yet little clear evidence—the main point is that by the aid of language, objects are not permitted to remain crude units, taken merely in bulk, so to speak, and responded to as a whole, with perhaps some vague spatial or temporal differentiations. This is, as we have seen, all that they can be for an animal that does not reflect. But they are forced to give up their wealth of distinctions and relations, which are attended to separately and named. They thus gain progressively a richness of meaning quite beyond the grasp of other creatures, which meaning is distinctively social in its significance. A box, for example, will become in a sense a significant object for a monkey when he has learned how to open it and get a banana that is inside. At least it means food to him; the part which he has to manipulate to open it is vaguely distinguished from the rest, and doubtless in his observation and play some few other qualities have dimly emerged. But to a creature who can analyze with the aid of language, a box means a far richer object than this, and through being richer, far more controllable for whatever purposes it can serve. The large number of qualities combined in the box take on individuality of their own—shape, height, length, color, hardness, roughness, weight, as well as the various relations between these, and between the box itself and the surrounding objects whose behavior it affects. All these and

many others can be considered by themselves, recombined in imagination, further analyzed into their own parts as occasion suggests, and thus open before the creature capable of such activities a kind of life vastly different from anything that could have preceded it.

In fact, the animal who thus fixes his observations by the use of language finds himself in a new world from that of his fellows. In the first place, it is a world of infinite variety. The limited number of meanings and distinguishable characters of the environment of his less analytic fellows has given place to an unlimited wealth of quality to which he can respond, and in which he can find enjoyment.

**Reflection first conceives general laws**

In the second place—and this is of still greater importance for understanding the nature of reflection—it is a world which can be reduced to general principles or laws. Vague causal connections are probably established at the level of imitation, at least the connection between some particular movement and the desired end which it brought about. But grasp of underlying principles or laws, applicable in all sorts of new situations, is possible only where analysis through language has been attained. Why is it that the man in our recent illustration could solve at once, with only a manipulation or two, the novel problem posed by the bolt on the door, whereas an intelligent chimpanzee is baffled by the addition of a second button to his box? Clearly because the man has acquired familiarity with certain general spatial and mechanical relations which he can recognize as present in a large number of different situations and respond accordingly, whereas the chimpanzee has only fixed a few relatively specific causal connections between specific parts of objects and desired results. But such general relations can only be brought to light by a long process of analysis, whose results have been fixed by language. The chimpanzee's knowledge is specific, and is thus transferable only to other specific situations closely similar. The man's knowledge is general, and is transferable to any situation involving the same general properties. He has advanced from a principle statable in this form: To get a banana in this situation, make a turn-

ing motion at this part of it—to one statable in this form: To open a door, free it from everything which interposes resistance to its swing. The latter obviously involves conceptions far less patent than the former, such as the abstract notion of resistance, which must have been very hard to discover, but which when grasped gave control over a thousand situations where the former was applicable to only one. It is by such advance from particular and limited rules of thumb to abstract underlying laws of universal scope that enables fumbling to be more and more transferred from overt performance to the realm of imagination. For in proportion as the recognition of the familiar elements in a situation takes place in terms of such general laws, embracing many specific relations under them, the scope of suggested solutions is widened and the power to foresee their consequences is extended. We all know the difference between the man who, when some machine breaks down, can only think of fixing it in the regular way, and is helpless till that is possible, and the man who can be counted upon to produce some expedient capable of making it work temporarily till the needed repair is made. The former does not see the parts of the machine in the light of the general laws which control their function. His imagination is therefore tied down to the particular structure which he has already seen there, while the other realizes that any object of such and such shape, hardness, and weight, or which can be connected in a certain way, will for a time accomplish the same result. The gain in rapidity and efficiency of adaptation through mastery of such general laws is incalculable.

Describing objects in their absence

In the third place, when objects can be thus analyzed in terms of their simpler components, and given stable names, definitions and descriptions of them usable in their absence are possible. They can be discussed when far from sensory contact of any kind, and to a great extent be identified and described to an individual who has never directly perceived them. It would not at all be difficult to describe the sea, for example, to one who has lived his life inland, sufficiently for him to identify it without trouble; and except for a few unanalyzable

qualities which had never come into his experience in any context, such as perhaps the salty tang of the sea air, one with good command of language might enable him to construct imaginatively and realize vividly the entire experience. To do this, of course, depends on the ability to analyze intricately in detail, to use precise and vivid names for the qualities and relations thus separated, and to stimulate the proper imaginative recombination till a unified feeling of the whole is won. It is precisely here that the power of the poet and the story-teller lies, indeed all great art demands fundamentally the same genius. The social advantage of all this in enabling others to foresee difficulties and solve them in advance of direct experience, is too obvious to elaborate.

Place of curiosity in learning

Turning to the psychological motive involved in this interesting evolution, the main point to bring out is that it demands from the very start the functioning of an interest in objects apart from the immediate use to which they are being put. Such an impartial absorption in an object, detached from direct control by specific desires, is what we mean by curiosity, and in it, accordingly, we find the main motive required. Were observation and imagination controlled entirely by the immediate activity which is being pursued, their fruits would never be useful for any other activity. Their meaning would be realized in terms of that activity alone, and their inner distinctions could never appear, to say nothing of the distinction between the thing observed and the outcome which attention to it makes possible. In other words, analysis demands that while, under the play of the distance senses, muscular action is inhibited, qualities and elements in objects should absorb attention which have no direct value for the needed action, but which, in their relations and consequences, it may be of use to recall in some later perplexity. Only in this way could those abstract and highly general qualities of objects emerge which furnish the basis for the establishment of underlying principles or laws such as have just been discussed. The first tendency, in a new situation, is to respond in the way suggested by the superficial resemblances of the situation to ones previously

experienced. Such responses often, of course, fail to work. If the animal has no curiosity he will learn a better response only by overt fumble and success; if he has, he will perhaps recall the way some other feature of the situation behaved in a past experience where it was of no particular moment—a rudimentary form of reflection. Response guided by this may solve the difficulty. If he then has a still larger measure of curiosity and a more vivid memory, he may seek to identify the common element between different successful responses to different situations, and the common element in the situations to which it corresponds, as, for example, in our method of opening doors, shutters, and windows.

Intellectual curiosity

When this stage has been reached he is on the verge of the discovery of general laws, and the attainment of what we may call a genuinely intellectual curiosity. By this is meant that advance has been made from a curiosity which is weak, fitful, closely tied to and easily quenched by specific impulse and action, to the beginnings of a systematic curiosity in revealing the general principle which can be used in the solution of any problem of a certain type. This is the disinterested curiosity of pure science, and it is at this point that the rudiments of *science* first appear in history. The aim of science is to reveal and make socially available, through language and education, connections of objects so far detached from immediate and particular desires that they can be used by anybody, anywhere, for the attainment of any end to which they suggest a relevant means. Curiosity thus reaches its culmination in what we call the scientific interest. There the ideal is clearly glimpsed of establishing a system of beliefs (to revert to the language used in chapter one) which shall be as dependable as possible at any given time, and a method of procedure which shall continually make them still more dependable and yet more widely useful. The symbols of science thus compose the language which is the deposit of reflective experience where it has become fully conscious of its generalized aim and of the necessary procedure by which that aim is to be attained.

So far as experimental evidence to date shows, man is the only creature who is able to learn by the method of reflective thinking. There are ambiguous experiments, supported by wider anecdotal testimony, which suggest that some of the higher animals—monkeys, horses, dogs, raccoons—can under very favorable conditions solve problems in a manner which in the light of the above discussion we could only call reflective. But the weight of evidence so far tends the other way. Man is *homo sapiens*—the reflective animal. By a thoroughgoing use of the method of observation and imitation, he rapidly acquired preëminence over his animal relatives, and by developing the habit of analysis in observation and imagery, funding its results in language, and extending it gradually to the more abstract elements involved, he transformed his environment into a new world, rich with beauty and meaning, and containing possibilities of hitherto unexpected control.

**Man alone able to reflect**

But it is important to remember that even in man the method of reflection has nowhere yet been realized to its fullest power; that except in a few richly endowed individuals it supervenes only fitfully upon habit and impulse and only then under the challenge of practical exigencies; that most men fail as yet to distinguish between beliefs secured by sound reflection and those due to imitation or tradition; and that man too must fall back upon the elementary method of overt fumble and success whenever he meets a situation which he cannot wholly analyze in terms of factors which have been reduced to general law. His reflective knowledge and adaptation are, therefore, never complete. The chemist experimenting with elements which he has never known combined, the boy facing a mechanical puzzle, the relations of whose parts he cannot entirely disentangle and hold in imagination, and for all of us the complex performances which involve coördinating various parts of the body, such as swimming, bicycling, dancing, etc., can never be learned merely by reflection, but demand overt doing for their mastery. As human beings we learn largely by doing and imitating, and it is only by the gradual advance of science and education that the method of fumble and success is more and more transferred

from overt action to the quicker and more efficient play of reflective imagination.

These characteristics of our human situation help to explain why our thinking often runs astray, and the satisfaction which we often take in unreflective and incorrect beliefs. To this theme we now turn.

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CHAPTER THREE

# HINDRANCES AND AIDS TO RIGHT THINKING

Emotion and desire in relation to stinct r flection and habit

IT IS evident from the preceding chapter that in respect to the fundamentals of his nature man is an animal like the other animals, living a life controlled in the main by the instincts with which nature has equipped him and the learned habits by which he has succeeded in adapting himself to conditions which original instinct could not meet. His main, if not sole, claim to superiority over them, in point of intelligence, lies in his capacity of abstract analysis and imaginative synthesis, by which the inevitable fumble and success element in meeting novel situations and establishing relevant habits is in varying degree transferred from direct overt action to the realm of imagination. But why is such learning ever necessary? Why not simply neglect the novel aspects of situations we face, recognizing in them only those factors with which our original equipment is able to deal?

To answer this question we need to take account of two other characteristics of human nature, something analogous to which doubtless exists in the lower animals also. These are *emotion* and *desire*. As the baby begins his life by responding to various features of his environment as his natural tendencies prompt him, he discovers that all these activities have an emotional coloring, varying from extreme pleasantness to its opposite. The pleasant situations he attempts to prolong, for that is what pleasantness means in terms of the overt behavior it stimulates, and if our original responses to all situations aroused pleasant feelings we should doubtless never be led to modify or replace them by learned responses. Instinct would rule the whole of life. But many situations in which our original reactions thus land us are painful rather than pleasant. The baby naturally

reaches for a bright ball, and the feelings which result from grasping and manipulating it are pleasant; just as naturally he reaches for a bright candle flame, but the resulting feeling in this case is extremely painful. And just as pleasure means in terms of behavior attempts to prolong the pleasant situation, so pain means attempts to terminate the painful situation. The emotional corollaries of his action thus force the baby to learn a distinction which to him is new, not supplied by his original equipment. He notes differences which he had previously neglected between a ball and a candle flame, and continues to respond as before to the former, while modifying his response to the latter, no longer attempting to grasp it as he did at first. This changed response is a simple example of the process called by psychologists conditioning. With this first lesson he begins in a rudimentary way to live the continually readaptive life which every learning organism must live. A third bright object appears within his reach. Some effect of the previous experiences being preserved, he now faces a perplexity. Which is this more like, a ball or a flame? Shall he respond by grasping it or by avoiding it? And, conditioned by the same fundamental factors, an elementary desire is now present. He wants by his response to produce a feeling like that of the ball rather than one like that of the flame. He checks a little the natural tendency to immediate response, while in a vague way he scans the ambiguous object in search for a clue. Of course, through meagerness of experience he can observe little that will helpfully guide him as yet, and his impulses act with correspondingly little restraint from past learning. But each lesson learned means the mastery of a larger number of points of similarity and of difference with objects yet to enter his experience, and it means, therefore, the possibility of check and of some guidance by the past in a greater variety of situations. As such lessons multiply, and imagination has more material from them to bring to bear upon present stimuli, he both finds himself faced by more perplexities and is able also with increasing confidence to use by reflection the distinctions made in getting him out of them. He is faced by more perplexities, because each new

situation that arouses attention reveals relations of similarity with a larger number of past experiences of contrasting emotional tone, some pleasant, some painful. Reflective consideration is more frequently demanded to decide which of these relations of similarity is the more trustworthy. He is able more confidently to deal with them because he has had more experience of the types of similarity that are apt to be trustworthy, and of the types that are not. Each choice is in a sense less blind than every preceding choice.

Moreover, as experience further expands, he generalizes what he finds to be the common elements in the enjoyable experiences he has had, and synthesizes them in imagination, constructing a picture of a kind of activity which he could expect to be more intensely and constantly enjoyable than any experience that he has actually had. This picture he strives to realize; it furnishes a positive attraction in addition to the more elementary repulsion of a painful experience. When the point is reached at which a large part of life is controlled by such imaginative syntheses, desire is functioning in its conscious and fully developed form.

Reflection as forming ends and selecting means

But since such appealing ends cannot be realized merely by envisioning them, he must look for appropriate means to bring them about. To build a house he must have blocks, to dig in the sand a pail and shovel. But due to the constant play of emotion the complexity of life is further increased by such experiments. Every activity involved in the making and using of these means has itself a direct emotional coloring, of pleasantness or unpleasantness. What happens then? The unpleasant ones discount the value of the end which they serve, as making the total situation which it involves less enjoyable in comparison with others; the pleasant ones increase the value of their end, and often come to outweigh it, so that what was first hit upon as a means to an end becomes an end itself and is thereafter pursued for its own sake, entering as itself a valuable element in the imaginative picture of the total activity desired. Piling blocks first to build a house, he happens by chance to make an intriguing tunnel; thereafter an afternoon with the blocks means

the building of tunnels as well as of houses. Generalizing from the recurring features of this process of enlargement, we may say that as the experience of a reflective being develops, reflection comes to be occupied with the formulation of ends of action and the selection of means for their realization. It is controlled ultimately by the emotional side of experience, as indicating the goals of endeavor which at a given time appeal most. Due to the constant and often unpredictable phases of this emotional pressure, the reformulation of ends and the attempt to discover new means is a continuous process. What we have found most enjoyable determines what at any given time we most clearly desire. What we desire in turn determines the nature of the ambiguity which novel stimuli show and guides the play of reflective imagination by which we attempt to solve the perplexity implicit in such ambiguity. In this concise summary we may express the essential manner in which reflection is related to those fundamentals of human nature which in the last analysis control our behavior. The reader may test the description by a survey of some recent chain of his own conscious experience.

With this brief enlargement of the psychological data dealt with in the preceding chapter, we are ready to embark on our present theme.

Why do we accept inadequate beliefs and tend to persist in them?

We saw that reflective thinking easily runs astray, in that it issues in beliefs which are not justified by the situation which they purport to interpret; furthermore, that we constantly tend to accept without criticism beliefs which are subsequently found to have rested on no adequate evidence. The ways in which a reflective act, once under way, may fall into mistakes, will be best discussed in connection with our analysis in Part II of a typical unit of thought. At present, however, we shall consider in the light of our psychological survey the more fundamental problem, how we come to have so many beliefs that are quite unsupportable by evidence, and why, once they have been accepted, it is difficult to replace them by anything more substantial. Only by such knowledge can we hope to combat these irrational influences and see how to do so intelligently.

Factors controlling the association of ideas

Let us begin with the point at which we left off in the preceding chapter and the outcome of our brief survey of human nature. Creatures have arisen in the course of evolution who are able to observe analytically the puzzling situations in which they are caught and who thus recall prior experiences not merely in bulk, but in the light of the analytic attention which has been given to them, that is, in the light of their elements and functional relations. But it is evident, in the case of any puzzling stimulus that attracts our attention, as we see from the discussion of the last few pages, that the relations of similar stimuli in the past have been various (for if they were not various it would arouse our response at once, without involving any perplexity) and the ways of breaking it up into parts are usually many—which of these relations shall be first selected as the clue to the solution of the present problem? A blaze breaks out suddenly, for example, in the kitchen of my home. Now a kitchen fire has similarities to many things in my previous experience—which of these will first suggest itself as a key to the present situation? Fundamentally, it is evident, from the comments just made, some similar experience which has a strong emotional interest, a vivid command of my attention. But experiences may be vivid in this way for various reasons. They may gain vigorous attachment because they have been frequently repeated in our experience, becoming thus indelibly enforced on our memory. They may gain it by reason of the fact that their occurrence was quite recent, so that the thought of them has faded less into obscurity than the thought of other experiences. They may gain it because they were modes of action by which we dealt successfully (and hence with a peculiar degree of satisfaction) with some related difficulty. Or, finally, they may gain it in some quite unpredictable fashion, which we can only explain by appealing to the accidental and unprophesiable aspect of our emotional nature—simply arouse more interest in us than others which, so far as we can see, might just as easily have had an equal appeal.

Now the psychologists have formulated these considerations in what are called the *laws of association*, or, more strictly,

the *factors of advantage in association.* These are expressed as the laws of *frequency, recency, vividness,* and *effect.* By the law of frequency is meant that we are so constituted that a stimulus tends to excite the response that has been most commonly made to it in the past. By the law of recency, that it tends to excite the response that has been most recently given to it, and whose performance is thus freshest in memory. The law of vividness expresses the fact that a response which was made with peculiar intensity, which brought to itself a live emotional coloring, will stand out in a special way in memory, and be more apt to be recalled. This is the part that unpredictable emotion, just referred to, plays in the matter. The law of effect means the principle which is apparent in all stages of animal learning, that the response which was finally successful in achieving the solution desired, will on that account gain peculiar intensity for future recollection.

The law of frequency the source of dependable associations

Well, it is tolerably clear that only when the play of our memory-images is determined by the first of these principles, and the fourth as controlled by the first rather than by the other two, will our past experiences of observation and analysis be used in such a way as will be likely to yield fruitful suggestions for meeting the present situation. Events which have been most frequently connected are the ones most likely to be connected again, hence if I recall at once the consequences that unchecked fire has usually brought about in the past, and the method which has been most successful in putting it out, analysis and memory are functioning in a way adapted to secure right beliefs and the consequent happy solution of my difficulties. In fact, where beliefs are involved which are essential to the preservation of life and the furtherance of accepted social ends, these two principles of association are reinforced in all manner of ways that secure the attachment of emotional intensity to right responses rather than wrong ones. The third law, in other words, is made to coöperate with the first and fourth rather than oppose them, and this means that the second gradually comes to conform as well. Within the field of such vitally necessary beliefs, then, there operate what Dewey speaks of as

certain physical and social "sanctions" of correct thinking—*i.e.*, forces which tend to eliminate false beliefs and support true ones. The burnt child dreads the fire—that is, the experience of pain attaches emotional intensity to the response of avoiding close contact with fire, and we have already seen that ease in acquiring such associations must be of decisive survival value. Similarly, it is true that the spanked child dreads the slipper —that is, intensity of emotional coloring is artificially attached to certain correct responses which are felt to be necessary by the group to which an individual belongs, in the interest of happy and prosperous community life. In such matters these forces direct the play of association toward the formation of correct beliefs, and their stabilization in habit, and secure *pari passu* the elimination of incorrect ones.

**Emotional attraction the primary source of superstition**

But in matters not thus vital to life and recognized social needs the second and third principles of association, particularly the latter, may dominate thinking, as indeed we see they must do as a result of the relation of emotion to desire and thought, and strongly suggest beliefs which are quite false and undependable. As Dewey remarks: "A savage expert in judging signs of the movements and location of animals that he hunts, will accept and gravely narrate the most preposterous yarns concerning the origin of their habits and structures. When there is no directly appreciable reaction of the inference upon the security and prosperity of life, there are no natural checks to the acceptance of wrong beliefs. Conclusions may be generated by a modicum of fact merely because the suggestions are vivid and interesting; a large accumulation of data may fail to suggest a proper conclusion because existing customs are averse to entertaining it." [1]

We have come upon the primary source of superstition and its accompanying errors in human thinking, as well as the oft-deplored conflict of emotion and reason. Something happens to add a striking emotional intensity to the memory of some observed fact. A friend who was present at a dinner party of thirteen is suddenly overtaken by accident and death.

[1] *How We Think*, p. 20.

The absorption of attention and interest by such a tragic event gives the relation between it and the earlier fact a peculiar vividness, which may secure that the number thirteen will be more apt to arouse the suggestion of dire tragedy, especially if recency coöperates, than responses which have been much more frequently connected with it, but which command no such vivid emotional support. Thus a persistent belief may grow up that thirteen is an unlucky number. The same principle, of course, explains many other superstitions, such as that it is dangerous to start a journey on Friday, that the path of a flight of birds will furnish guidance for military campaigns, that sacrifices will bring rain, that certain articles of diet are dangerous. Most of the taboos which are so common in primitive life and which gradually shackle it by a multitude of quite unnecessary restraints doubtless owe their origin to the vivid association of some casual performance with a subsequent happening of dire social consequence. Before emotion becomes attached by a larger grasp of experience to more adequate beliefs, it is as natural to prohibit acts which vividly suggest dangerous outcomes as those which have been frequently observed to lead to them.

**How fallacious notions expand**

Now when a number of erroneous beliefs have in this manner become established in acceptance, other powerful factors operate to develop them into a larger fabric of error and to secure their permanence.

With respect to the first of these two points we need to remember that suggested solutions of subsequent problems tend to be congruous with beliefs already accepted, and if the practical or social pressure toward a correct answer is not strong, suggestions which dramatically harmonize with prior errors will be incorporated into the scheme of accepted beliefs without check. Thus having become persuaded that natural objects around him were possessed of personal forces like those he found in himself, beliefs in fairies, nymphs, gnomes, and picturesque tales about them naturally followed in primitive man's mind. Or believing through dreams, perhaps, that dead ancestors were somewhere living the same kind of life that they had

lived here, the practice of providing them with homes, weapons, and food became a natural further response. Whole systems of ideas thus grow on the basis of a single accepted idea, and if the latter is without adequate foundation a vast tissue of error may accumulate around it.

In one of its prominent aspects this process of embellishment may be fruitfully pursued a little farther. Consider how creatures who, like man, have reached the level of learning by the aid of observation and memory-images, find the latter constantly outstripping and anticipating overt action—indeed, were such not the case, the peculiar character of imitation and reflection as compared with fumble and success learning, would be impossible. Now while such an animal is trying to solve a difficulty, this added play of imagery is focused on the puzzle in hand, but in its moments of satiety and leisure the analytic observation and accompanying stream of images will still continue. This gives us the type of thinking which in the first chapter we called reverie or daydreaming. Since no practical pressure now controls the stream with reference to a definite end, there will be nothing at all to prevent the entire control of associations by immediate emotional interest—that is, the third principle of association will be quite unrestrained by the fourth, and only partially checked by the first and second. Couple this fact with the one just noted, that it is only in matters of vital concern, and even then chiefly as regards material things upon which trial can at once be made, that children and savages will of themselves learn how important it is to distinguish between beliefs established on evidence and those not, between fact and fancy, and we see how nature-myths, once given a start, may grow to fantastic proportions. Inferences will take the way of building an exciting drama rather than the sober body of science. We see essentially the same process revealed today in the way in which gossip, given an interesting belief on which to start (whether with or without adequate evidence), will run a course of magnification in successive tellings which is almost impossible to check and whose final product it is hopeless to refute. The play of imagery, stimulated in one person's mind

by the story as heard from another, will be so vividly occupied before he communicates it to a third, that some entertaining addition will be incorporated in the tale, and the adventure in its final form will be marvelous indeed. In just the same way the savage, as he sits before his fire at night in an hour of leisure, will imagine interesting annexes to the beliefs already accepted and furnishing enjoyable stimuli; animistic tales about the performances of nature will develop and spread; soon traveling story-tellers or bards will appear whose very profession it will be to combine and expand these yarns and put them into the most stimulating shape by the aid of music and rhythm. One interesting error thus inevitably begets another, and without the checks furnished by painful consequences of false beliefs, or a growing habit of loyalty to fact and growing power of distinguishing it from fancy, a large accumulation of superstitious notions will become the heritage of each generation.

When thus established and growing, a mass of errors tends for many reasons to retain its hold on the groups which have come to accept it, despite frequent occurrences which would otherwise throw doubt upon this or that particular belief.

Superstition perpetuated by education

Foremost among these is the influence of education in instilling the accepted traditions of the tribe in the minds of the young, while they are yet thoroughly docile and quite uncritical. We may note in passing the direct bearing upon this of the facts brought out in the preceding chapter respecting the stage in the development of learning that we have called imitation. All human beings pass through this stage in their growth toward maturity, where they assimilate by a process of intellectual absorption ideas acquired in the experience of previous generations without needing to repeat the overt actions by which they were first established. The tremendous importance of this in the building of civilization was there dwelt upon. But, given the natural instincts making for submission and obedience, it is clear that this method of imitation, in itself, will be just as apt to rivet in the minds of the young the superstitious notions of their elders as the more dependable ones, and thus perpetuate error as easily as truth. This transmission of ideas is in part

conscious, expressed in overt educational practices; in part it is the still more effective because gradually insinuating permeation of thought-habits by ideas present implicitly in all that is done and said. What is consciously taught may often, in some vague way, be questioned by a clever youth; what is unconsciously imbibed simply because it is everywhere implicitly acted upon, meets no resistance at all. It is acquired and believed with no more criticism than the habit of joining in the hunt or of eating when the family dines. Most of us will still find that a large number of our most fundamental and pervasive beliefs were gained in no more rational manner than this unconscious absorption and passive imitation of what in the days of our trusting youth constituted the ideas among which we were growing to selfhood. That it should be thus is quite inevitable, for we are not born sceptics. The habit of viewing beliefs critically, of taking what parental authority or group tradition inculcates "with a grain of salt," to say nothing of engaging in doubt in a thoroughgoing fashion, is a kind of wariness which can only be gradually forced on one by the experienced difficulties into which he is thrown through a too ready acceptance of prevalent notions. Otherwise, as we see, there could be no adequate motive to doubt. Education on its informative side thus becomes, throughout by far the greater part of human history, an instrument for indoctrinating youth firmly in the accepted beliefs of the tribe, and fostering by every art its native attitude of innocent submission and unquestioning trust. And by informative education is meant the work of all the social agencies, including the family, religion, etc., which function toward this end.

Superstition be-

When boys and girls thus emerge toward maturity they find themselves the heirs of a mass of notions which have been taken quite passively and without question, but which are as much a part of themselves as their muscular skill and their second teeth, and which furnish the intellectual eyes through which they are forced to view the world of their experience. What is there to upset these notions, however inadequately based, even then? If a boy be adventurous and exploratory

by nature, some few of them will get him into practical trouble; this will perhaps stimulate him to try another response inconsistent with the previously accepted belief, which he may find more successful. Thus he may be led to the revision of some of his beliefs in the direction of more adequate opinions. But by far the greater number of his ideas are not thus vital to his practical welfare. The natural checks to continued acceptance do not operate in their case, while on the other hand there are two very important psychological characteristics that strongly support continued loyalty to tradition.

**Painfulness of doubt or suspense**

In the first place, the period of doubt or suspended judgment which necessarily intervenes between the casting of distrust on an accepted belief and its replacement by something better, is naturally quite painful. It involves an inhibition of habit, of the smooth discharge of energies in an accustomed direction, in precisely the same way as the attempt to break any other habit, such as swearing when hurt, or feeling blue when disappointed. Now the exercise of any smooth-running tendency is naturally pleasant, resistance to it painful. And underlying this painful resistance to a forced change of habits there is a principle of biological protection which takes its special form in the case of beliefs. Well-formed and smoothly running habits are essential to rapid action. If decisive action is needed while one habit has been given up and before another has taken its place, it is not apt to be forthcoming. Whatever action is given will be slow, hesitant, and weak. As concerns beliefs, this means that the individual in a state of suspended judgment is not able to act confidently, either on the basis of the previous idea, for that has been made doubtful, nor on the one which in time will replace it, for that is yet to be established. He feels himself thus in a practical helplessness which is the source of a considerable part of the pain which accompanies the reorganization of habit. Only gradually does the greater satisfaction of the more adequate succeeding belief associate itself sufficiently with the preceding sense of doubt so that it counteracts the natural painfulness of the latter and renders it tolerable.

One of the tests of a thoroughly critical mind is that such association has been definitely established and generalized.

Tendency to justify our beliefs instead of correcting them

In the second place, all our immediate instinctive reactions which serve the purpose of self-defense tend to be mobilized in support of the things that become our possession through the course of individual experience, just as they do in support of those with which we are born. Just as our instinctive response to a physical blow is to ward it off and protect the threatened part from injury, so do we respond when danger menaces our house, our children, or our Ford. Now the threat may be intellectual and emotional, so to speak, rather than physical. I may know perfectly well that my pet dog is nothing but a lazy, cowardly cur, without a virtue save his attachment to me; but if anybody else should make such a suggestion, at once an angry defense complex is roused. I fly to defend him with the highest praise, and nothing is farther from my intention than to engage in an objective inquiry to determine how far the insinuating remarks are true. The same principle, of course, operates in the case of our ideas about the universe and everything important in it—the Bolsheviki, the League of Nations, the Republican program of tax reduction, the theory of evolution, feminism, divorce, the size of our navy, the crime wave, short skirts, the right way to make a garden, the best way to treat hay fever. Few of these matters have we really studied out in any systematic fashion so as to gain rationally justifiable views about them. Our beliefs have been imbibed, how or why we hardly know, but mainly in the quite irrational way described above—through the insinuations of the newspapers, the wiles of a party orator, the prejudices of our friends, the instinctive sense of advantage to our business interests. But let a question be raised as to the validity of our notions on these things, and at once we find ourselves filled with an illicit passion for them. Our first response is bitterly to defend them in precisely the same way that we should defend a punched shoulder. The problem as to how rational they really are does not trouble us. We refuse to learn truth from a foe. And in fact the hotter and more violent defense is provoked in favor

of those ideas which have the least intelligent justification, those which we have acquired merely by subconscious imitation of the prejudices around us. The reason for this supreme pitch of irrationality lies in the fact that those beliefs which we have reached through some thinking, however meager, we know can be doubted, while those which we have absorbed as implicitly as our mother's milk are so firmly rooted in our entire make-up that to question them seems at first sight like scepticism carried to an insane degree; when they are assailed we instantly fly to protect them as though they were the most precious and eternal things about us, whereas we shall be more ready to reopen inquiry into those which we originally reached by some effort at impartial thought. This tendency to intellectual self-preservation, to defend our ideas rather than find out the truth about them, is technically termed *rationalizing*. It takes various forms in detail, all of which are destructive to honest thinking. The most popular of these is doubtless the search for an ostensibly good reason—that is, one socially acceptable—for going on believing and doing what we are already determined to believe and do, how or why we hardly know. Our party should be continued in power because the country has been prosperous during its régime; votes should not be given to women, because the home should not be allowed to suffer. One difficulty which the man of earnest moral interest finds in the still popular tendency to accept a set of scriptures, however lofty in their ethical spirit, as an absolute authority for conduct, lies in the ease with which verses can be selected for rationalizing purposes, by those who wish to do so. He is a poor student of the scriptures who is unable to find some verse which can be interpreted to sanction his doing what he is strongly determined to do anyway. A clergyman of international reputation preached some years ago a sermon on the text: "Lay not up for yourselves treasures on earth, where moth and rust do corrupt," in which he pointed out that the modern enterprising business man does not really violate this prohibition; he places his funds in bank vaults which are specially constructed to avoid these undesirable

consequences, or he invests them in stocks and bonds, which a simple box will amply protect!

So deeply rooted in instinctive defense-reactions is this tendency to rationalize that but few people are able to take adverse criticism of their ideas genially, even though the ideas in question be but tentative and casual opinions. The urge to ward off such criticism is exceedingly insidious and difficult to overcome. Being on a committee appointed not long ago to make arrangements for a certain social affair, the writer jotted down with almost no thought a suggested program and brought it to the committee meeting. Though it was thus hastily concocted, some tendency was noticed to defend it against other suggestions simply because of its origin.

**Mental inertia**

Among the related psychological factors which can always be counted upon to support rationalizing is our general mental laziness and inertia. Particularly does a reconstruction of beliefs meet resistance when a lot of other cherished notions are bound up with them so that serious doubt will precipitate a collapse of our whole mental machinery. Here is an idea which I have come by without any effort, and I am resting nicely in cherishing it; if you come and take it away from me I shall have to go to some effort and toil to get another in its place; moreover, the idea is so fundamental that I feel a lot of other ideas dependent on it and liable to be upset with it. The belief that the earth is the center of the universe and that species of animals were separately created are historical examples of such basic ideas. It seems, so to speak, to conservative minds, like breaking a treaty of intellectual peace and precipitating unjustifiable warfare, to seek to overturn beliefs on which the whole fabric of accepted science and philosophy rests. The emotion of shame is likewise a contributing motive. One realizes that the thinking by which much of his mental furniture has been acquired is thinking of the imitative sort, but he is rather ashamed to admit it. He knows that as a man he is supposed to be reflective, for reasoning is in some sense the privileged occupation of man as man. He refuses to acknowledge that he has fallen below the standard of reflection; he is eager to

appear to others and himself more human than he really is. Hence a readiness to rationalize his beliefs instead of coöperation in the attempt to make them more rational. He throws a camouflage of socially acceptable principles over the gap between his real motives and his overt conclusions, a nice deception of others and still more of himself to cover up the childishness of his actual performance. This aspect of the tendency to rationalize has been much dealt with in the Freudian psychology.

Difficulty of securing a motive for overcoming superstition

It is, of course, obvious that the same factors which give rise to incorrect beliefs and make their criticism so difficult will operate to abbreviate, confuse, and render ineffective a train of critical or constructive thought once it has somehow got started, unless some vital interest appealing strongly to our emotions, is felt to be so immediately dependent on it that a controlling motive can continue to function. Otherwise the thinking, driven by insufficient motive power, will soon fade and evaporate, or wander in illicit directions. Primitive people are notorious for their inability to concentrate on an idea for any length of time, except, perhaps, when engaged in war or the hunt. This means that it is only by a long and gradual process that strong motivation comes to be attached to thinking not directly focused upon some practical need, and that an intellectual curiosity in the attainment of principles usable in various sorts of perplexity can develop.

Social repression of new ideas

As if these forces in the individual making for conformity with the beliefs of his group were not enough, social pressure is exerted in various ways to insure that anybody who shows a tendency to think along dangerous lines will be brought to terms. As all who have studied the organization of early societies are aware, an intellectual censorship of the most repressive sort is almost universally instituted; to question the accepted beliefs of one's fellows along lines regarded as socially important is the most heinous of crimes, not to be tolerated in the least degree.

The way in which such repression becomes a custom is in part explicable by the functioning in social relations of the factors in human nature already cited; in part further points

need to be held in mind. It must be remembered, for one thing, that an entirely sound instinctive feeling underlies this custom. The group must be coherent and unified to the last possible degree, to insure success in securing the means of group maintenance and in withstanding external attack by united effort. Anything which introduces uncertainty, hesitancy, or social discord is rightly felt to be prejudicial to success in the struggle. Now the criticism of existing beliefs, to say nothing of fostering a sceptical attitude generally, unquestionably does introduce these things; its first effect is always to disrupt social unity and produce a rebellious individualism. The very foundations of social welfare are thus felt to be imperiled by anything which weakens the traditional beliefs of the group. Accordingly, in all ages except the rare ones in which intellectual initiative has itself come to be socially prized (of which more anon) the reformer in matters of belief is regarded as a menace to society, to be treated accordingly.

**Authority centered in fossilized minds**

Were those in control of society men in younger middle life, as tends to be the case in modern competitive industrialism, this repression would probably be not very severe. The leaders of the group would not be so far removed from their own days of incipient lawlessness to forget entirely the sweets of a little freedom and the value that such initiative may promise. But primitive societies are uniformly in control of the oldest men in the group, whose habits, intellectual as well as other, are completely fossilized, and who insist that the few novel decisions which are made for the group shall be made by themselves. The causes of this form of social organization are complex but entirely natural; among other things, in an age preceding the keeping of written records, it is clear that only in the elders can the full traditions of the tribe be vested at any time. And of course the spontaneous reverence and submissiveness of children toward their parents ceases at no given age.

**Religion a conservative force**

Authority is thus unremittingly exerted to preserve loyalty to the accepted doctrines, and as religious institutions develop, fear of the penalties imposed by the dead and the gods is added to fear of the living as a force toward intellectual conformity.

Nothing, assuredly, will constitute such an insult to the deceased ancestors of the tribe as laxity in preserving the beliefs and practices which they wholeheartedly accepted when alive. Nothing, accordingly, will be more sure to bring immediate and devastating punishment on the tribe than toleration of any individual who takes lightly the sacred traditions. Unquestioning belief in what has become accepted as true and socially important, and readiness to act implicitly upon it, thus become the primary religious virtues, for if the gods are not identical with the remote tribal ancestors they are believed to possess, in these respects at least, precisely the same jealous qualities. Since they are the invisible comrades, protectors, and rulers of the group, dispensing prosperity and woe with mighty hand, it is supposed that every established custom that has usually been attended by happy results must be precious to them; and therefore any attempt to change these is an affront to the tribal deities, the certain prelude to dire punishment, delayed if not executed at once, in another world if not in this. Religion becomes the mightiest force of all for intellectual conservatism. Furthermore, as religion develops, a priesthood also grows, and waxes more and more important as a social authority. The temptation to abuse this power, in intellectual as well as other ways, is often too strong to be resisted. The will of the gods can only be ascertained in special ways, of which they are the custodians; sound doctrines can only be made known through special agents, which are none but they or their initiates. They gain thus an intellectual authority which almost none can withstand, since through their privileged position they can wield invisible powers toward weal or woe. Do you venture to question the absolute truth of their pronouncements, to social ostracism in the present they will add the pledge of eternal damnation in the future.

Clues to many important truths obscure

In face of all these vigorous forces working toward the establishment and maintenance of error, one might well wonder how true beliefs should ever be reached at all, or made to replace false ones. But there is a consideration not yet mentioned, which adds enormously to the difficulty. This is the fact that

the clues to the real causal relations of events, which thus furnish the only dependable key to their control, are often very obscure and remote, requiring both a high degree of intellectual power and a long course of baffled experience before they could be suggested to anybody's mind. The connection between a severe fall and the resulting pain offers little tax on analytic memory once it has been attained in the most rudimentary degree—but how should anybody naturally hypothesize the bite of a mosquito as the cause of malaria? The association between the two events is surely distant and far from obvious. Only a very fertile imagination, fortified by long experience of the advisability of being ready to replace superficial analogies by hidden clues, would be apt even to think of the possibility of a connection. How difficult this is becomes evident if we note the almost incorrigible tendency of the popular mind to confide in superficial and attractive analogies even when the beliefs involved are of some practical concern. An old country lady, being challenged to justify her belief that it was dangerous to pare corns in the new moon, replied, "Well, while the moon is growing big the corn will grow big too, won't it?" And the persistent belief in seaside communities that births tend to occur at the full tide and deaths at its ebb is another illustration of the control that a superficial analogy can exert. The relation of this to reverie and the play of the laws of association recently discussed will be sufficiently evident. The discovery of some of the most important causal laws is thus an exceedingly difficult affair because the kind of analysis and connection which needs to catch attention is very unobtrusive. It seems like a silly waste of time even to entertain some of the suggestions that later become thoroughly verified. Some, indeed, require for their hypothesis an equipment which man with his unaided senses does not possess. Without a microscope and the other appliances of modern medical science, how should anybody guess that a minute organism in the blood stream is the real cause of typhoid fever? Yet it is through the discovery of such organisms that medicine has undergone the most beneficial revolution of its entire history.

Forces that support right thinking

How, then, is it that we are not completely lost in error, that some dependable beliefs have actually been hit upon, and others, after a long struggle, have been made to replace the superstitions which preceded them? So far as concerns the beliefs which directly affect life and material prosperity, the answer has already in substance been given. Sound reflective thinking and the truths in which it issues are here supported by the evolutionary struggle itself. Its survival value is so great that, other things being equal, it will win out over less effective modes of learning, and particularly over the uncritical and submissive imitation of the beliefs of others. As we have already seen, it possesses their virtues and more—consequently, where life and accepted values are obviously at stake the method of reflection, once hit upon, will be preserved and grow. The law of frequency may here come to play a larger and larger part in the control of beliefs. But how should it come to be applied to beliefs which have no vital utility, in competition with all the forces making for erroneous fancies with which we have just been occupied?

Complete rigidity of belief impossible

The first answer to be given here is that the circumstances which any group faces vary sufficiently to make it fatal for absolute rigidity of belief and custom to be maintained. A deluge or drought, a large change in temperature, the exhaustion of hunting grounds or the need of securing different animals for food, a sudden attack by a new enemy, impose novel problems which have to be met in novel ways. A certain premium thus comes to be put by a successful group itself on initiative and individuality; the individual who reconstructs beliefs is rewarded with honor and leadership in ways which inevitably, in the younger and liver minds, lead to the setting aside of restrictions which no longer seem relevant, and to the consideration of novel answers to questions which are not of such practical moment.

A leisure class expands the range of curiosity

Thus more efficient means of building shelter, of hunting, of carrying on war and agriculture, become gradually established, and a certain encouragement of free analysis and constructive imagination develops. Stabler civilizations then appear, which

enter into various diplomatic and commercial relations with one another. The sceptical and disintegrating effect of contact between sets of contradictory beliefs begins, and as such contacts increase gathers much momentum. Conscious recognition of the changing character of the circumstances to which adaptation is required leads to the introduction of flexibility into the tools which have been developed to deal with such circumstances. This means, on the material side, the invention and perfection of machines capable of achieving the same desired end in relation to different objects. On the side of beliefs it means science—that is, the establishment of general laws so formulated as to give dependable guidance in junctures which vary much in detail from one another, and the gradual fostering of the attitude of mind and the experimental technique which functions in the correction and expansion of these laws. The transfer of this process in any thoroughgoing way to beliefs which are not of direct practical concern has depended historically on the rise of a leisure class, supported in comfort without the need of physical labor, their energies freed from immediate practical concerns. The appearance of such a class was in turn conditioned by the laying up of economic capital and the acceptance of aristocracy as a social institution. But the powers of analysis and constructive imagination of such a class, once it appeared, were inevitably applied to the rationalization or criticism of the moral, political, and religious beliefs with which they were familiar. In Egypt and Asia rationalization and metaphysical completion of the beliefs already representing their dominant interests, was the chief character of the thinking which thus developed; in Greece criticism became more thoroughgoing, and the first period of intellectual history appeared in which a sceptical revolutionizing of traditional notions was the obvious note. Still, the divorce of this intellectual class from the need of practical control of the main conditions of life postponed till modern times the establishment and prosecution of science as a continuous, developing institution, in favor of theology and metaphysics. Intellectual curiosity first developed,

and had to develop, in a condition of privileged freedom from the practical pressure of life; it only gradually became applied, with full consciousness of its significance and method, to the problems of life as the common man faces them. The process, viewed in its larger historical bearings, is thus one in which reflection, having revealed its value and gained its discipline in competition with other methods of meeting the primary needs of life, becomes applied by a leisured aristocracy to more remote and luxurious problems; this expansion of the range of curiosity continues until it becomes so nearly impartial in its freedom from immediate concerns that we call it an interest in truth for its own sake. Then, as in course of time the principles established by such men show obviously valuable applications in promoting a stabler civilization and securing larger comfort and a finer culture for others, instanced by such inventions as the compass, the telegraph, the radio, science and its method slowly win general respect and prestige, finally reaching the point where the forces which so vigorously make for new errors and the preservation of traditional ones are no longer able to crush it or prevent its advance.

Criticism of traditional ideas and the reconstruction of beliefs thus becomes itself a habit, backed by growing social approval, and tends to supplant the habit of mere acceptance of prevalent notions. So far as this interest in understanding how things really happen becomes the dominant interest in any individual, and the habit of criticism in terms of it becomes the controlling habit, so that other interests are made for the time being subordinate, it is evident that thinking cannot fail to function rightly, to the extent that right thinking depends on our own will and character. For we are rational whenever we are not irrational —that is, it is only necessary for biases and prejudices to evaporate for thinking of itself to proceed in as correct a manner as under its contemporary environment it can. To state the matter this way is to view the task of right thinking in a more encouraging light than a consideration of the hindrances alone would permit.

Whether this happy situation has even yet been definitely reached is perhaps a matter for debate; at any rate, it is only in modern times that hope has at all been justifiable that it would be reached. Yet in a somewhat larger sense science is of course not merely a modern institution. Rudimentary scientific laws are found and begin to be handed down from generation to generation as early as man's analytic observation and memory note recurring relations in natural events, and his use of language has developed to the point of giving them significant expression. The form that these take at the beginning, and the ways in which they grow with the advance of reflection, we shall briefly observe before concluding the chapter.

In a larger sense science began with the first generalizations from experience

The earliest results of reflection in the discovery of general laws or principles present themselves in the form of "sayings," brief guiding mottoes, which, as handed down in many primitive languages, we should call *proverbs*. Some of these are concerned with processes in external nature, some with human relationships, but all are of direct practical value. The imperative form of statement, in which they often fall, reveals this as well as the content. Many are concerned with directions for successful agriculture or hunting; those have by our day so far been replaced by more scientific knowledge that those which still persist have taken on a metaphorical significance. "Make hay while the sun shines;" "Store away for a rainy day;" "Dropping water wears away stone"—are as good examples as any from those which have been handed down in our Anglo-Saxon tradition. Some which reveal observation of recurrences in other phases of life are: "Nothing venture, nothing have;" "Red at night, sailors' delight—red in the morning, sailors' warning;" "Prosperity rewards the industrious;" "A soft answer turneth away wrath, but grievous words stir up anger." These constitute brief expressions of common uniformities noted in the course of man's experience and handed down in the form of language for the guidance of others. They are morsels of order extracted from the caprice and chaos of man's early environment, and were, of course, largely supplemented by the simpler spatial and temporal regularities which

Form taken by primitive generalizations

had been mastered so early and taken for granted so constantly that there was no occasion to formulate them in language at all till the conscious attempt to develop knowledge into a comprehensive system came to be made. Such sayings, accordingly, represent the earliest form of causal laws definitely stated by man, and may be called the rudimentary forerunners of large modern generalizations like the law of gravitation and the theory of evolution.

Growth of scientific knowledge in (1) unity

By what main processes do these rude beginnings of science develop into a more complete and exact body of scientific knowledge? We shall be occupied with some phases of this question later; at present it will be sufficient to note that they (1) become more systematized and unified, (2) greatly expand in number, and (3) grow more precise and exact.

(1) The sayings and implicitly recognized regularities with which science begins are disconnected. They are scattered uniformities, each of meager range, and unifying underlying principles remain to be discovered. As science grows they become more and more connected by being shown to be merely applications, under specific conditions, of more general laws. The facts that dropping water wears away stone and that the planet Venus moves in a certain orbit modern mechanics shows to follow from a single set of principles, whereas primitive thought had never dreamed of the remotest connection. Even a much simpler unification—that of the rise of a balloon and the fall of a stone—had to wait for science to reach sufficiently general laws to recognize and explain verifiably the behavior of bodies lighter than air.

Moreover, in many cases primitive sayings even contradict each other. "Haste makes waste" and "The early bird catches the worm" are surely not quite in harmony; another example is "Nothing venture, nothing have," coupled with "A bird in the hand is worth two in the bush." A modicum of experience teaches us that there is some truth in each of such antithetical proverbs, but we cannot get much confident guidance from them as long as they remain in this unreconciled form. Science proceeds to unify in such cases of conflicting laws by securing

a deeper and more careful analysis of the relations in question. It is evident that each of these laws is stated in too general a form to permit of full verification; instances occur which refute it and uphold the contradictory principle. What is needed, then, is to locate precisely the conditions under which the one is true and those under which the other holds good, so that when they are stated as limited by the conditions both will be fully true and dependable for practical guidance. To take the most recent of the above examples: conservatism is clearly advisable under certain conditions, such as ill health, old age, and meager savings; taking a risk advisable under others. Science is not satisfied until these are noted and stated as precisely as contemporary technique makes possible.

(2) scope

(2) Then, of course, as science advances, primitive causal laws greatly increase in number. As life becomes more secure through the discovery of some, opportunity is won for observation to discover more. Gradually more and more of the world of man's interest is covered by them. No side of life is left wholly the prey of caprice and fancy. The order in which this expansion takes place is determined mainly by the factors with which we were occupied earlier in the chapter. At first laws are formulated covering those relations which it is most necessary to control in the interest of continued life and group stability, and in which, therefore, prejudice and misguided emotion have less opportunity to confuse analysis. Gradually, as respect for fact deepens and interest in it broadens, uniformities become noted in matters of less primary importance and more involved in bias, until finally it becomes possible to engage in objective study of prejudice and emotion themselves, analyzing them into their recurrent relations and establishing the beginnings of scientific knowledge of such phenomena as religion and morals, where emotional obstructions and passionate loyalties stand most powerfully in the way.

(3) exactitude

(3) In the third place the advance of science is an advance in the precision and exactitude with which its laws are stated. The first results of analysis are naturally vague, and the outlines of meaning of the terms used to describe them are hazy.

As elements and relations are penetrated in greater detail, the exact range of meaning covered by the descriptive phrases used is correspondingly clarified. Thus some meanings are gradually sufficiently freed from a vague penumbra of experience to gain complete definiteness and constancy, so that a man may always know exactly what he signifies by them and exactly what others signify when they use them. As soon as any results of analysis of this sort are at hand and functioning in thought, the tendency inevitably becomes strong to see if other types of event cannot be analyzed into units of the same kind, so that an equally definite understanding and control may be secured in dealing with them. In the history of human thought it is the concepts of mathematics that gained this privileged position. The relations of number and of spatial position early won such unique precision and consequently such certain application that the effort to make them fundamental in all sciences quickly followed, at first speculatively, as in the Pythagorean and Democritan schools in the ancient world, then more concretely and empirically, as in ancient astronomy and mechanics, and in modern times increasingly in all branches of science. Exact science has come to mean, in human history, quantitative or mathematical science.

Acceleration of man's intellectual progress

One of the most noticeable and hopeful concomitants of the enlargement of reflective power in human history and the clearer consciousness of its value and method, is the acceleration of intellectual growth, and of the attainment of other values which depend on it, that is so manifest as one surveys the course of man's evolution. After man's physique and brain structure had attained substantially their present form, it still took tens of thousands of years (perhaps more) to establish even the rudiments of civilization—the use of fire, the domestication of animals, the invention of simple tools for hunting and defense—and only two hundred years ago it was yet possible for an intellectual genius to master all that was known in every branch of learning. Today revolutionary changes in even such conservative realms as morals and religion seem to take but a few years, new discoveries and inventions of moment are appearing

with startling rapidity, and the most irresistible force moving toward consolidation in the business world is the inability of small concerns to keep up with the newest applications of chemistry or electro-magnetism to industry.

Nothing is more essential in our attempt to escape from the bondage of consecrated ideas than to get a vivid notion of human achievement in its proper historical perspective. In order to do this let us imagine the whole gradual and laborious attainments of mankind compressed into the compass of a single lifetime. Let us assume that a single generation of men have in fifty years managed to accumulate all that now passes for civilization. They would have to start, as all individuals do, absolutely uncivilized, and their task would be to recapitulate what has occupied the race for, let us guess, at least five hundred thousand years. Each year in the life of a generation would therefore correspond to ten thousand years in the progress of the race.

On this scale it would require forty-nine years to reach a point of intelligence which would enable our self-taught generation to give up their ancient and inveterate habits of wandering hunters and settle down here and there to till the ground, harvest their crops, domesticate animals, and weave their rough garments. Six months later, or half through the fiftieth year, some of them, in a particularly favorable situation, would have invented writing, and thus established a new and wonderful means of spreading and perpetuating civilization. Three months later another group would have carried literature, art, and philosophy to a high degree of refinement and set standards for the succeeding weeks. For two months our generation would have been living under the blessings of Christianity; the printing press would be but a fortnight old and they would not have had the steam engine for quite a week. For two or three days they would have been hastening about the globe in steamships and railroad trains, and only yesterday would they have come upon the magical possibilities of electricity. Within the last few hours they would have learned to sail in the air and beneath the waters, and have forthwith applied their newest discoveries to the prosecution of a magnificent war on a scale befitting their high ideals and new resources. This is not so strange, for only a week ago they were burning and burying alive those who differed from the ruling party in regard to salvation, eviscerating in public those who had new ideas of government, and hanging old women who were accused of traffic with the devil. All of them had been no better than vagrant savages a year before. Their fuller knowledge was altogether too recent to have gone very deep, and they had many institutions and many leaders dedicated to the perpetuation of outworn notions which would otherwise have disappeared. Until recently changes had taken place so slowly and so insensibly that only a very few persons could be expected to realize that not a few of the beliefs that

were accepted as eternal verities were due to the inevitable misunderstandings of a savage.[1]

How far does it justify optimism?

According to Genesis, Methuselah lived nine hundred and sixty-nine years by the sun, but it is safe to say that there was not as much doing of live human interest in the course of his lifetime as there is in the ordinary man's threescore years and ten today. And in spite of such massive and ominous tragedies as the Great War, there is much ground for intelligent optimism in this acceleration of progress. Our ideals are laid forth on a grander scale than ever before, but if they are rational enough to respect the realities on which they must be grounded, it is likely that they will be realized far sooner than we should dare to expect, and enable men of earnest energy to move on in the guidance of still more brilliant dreams. Consider, as a single striking example, the difference between Nansen's long, hazardous, and ineffective Arctic wanderings a generation ago, or even the story of Peary's exploit in 1909, and what modern aëronautics, together with such inventions as the wireless and the radio, have since made possible. Captain Amundsen himself, in describing his transpolar flight, dwelt again and again on precisely this contrast. "Now, sitting here in Nome, looking back on the different expeditions I have taken part in, the last one seems to me unbelievable. When I started exploring in the polar regions we had to utilize the same means that had been used for generations. And now, thirty years afterward, science and technic have made it possible in days to explore regions bigger than could have been explored in the same number of years before. The risk of flying over ten thousand square miles in a few hours today is not greater than before to go in the ice with a ship.

"Due to the wireless, the explorer today can fix the best moment for starting through the air, and due to the wireless he can during the flight choose the route where the weather conditions are best. Even in fog he can continue his flight by radio bearings. Before, the world did not get news from him after he had passed the frontier between the known and the

[1] J. H. Robinson, *The Mind in the Making*, pp. 82-85.

unknown; now he is enabled to tell the world how his expedition goes on from hour to hour. And after his return, due to modern photography and moving pictures, he can give much richer impressions of what he has seen than ever before."

Then Amundsen concludes with a recognition of the continuity of scientific growth and the dependence of every later achievement on the earlier fumblings of self-sacrificing men who gave life and toil and suffering to make the greater success of others possible. "But the modern explorer who utilizes all the inventions of his own time does not forget that before him for centuries others have gone into the unknown and returned with observations and knowledge he builds upon. The difference between exploring in the Arctic and the Antarctic before and in our time is therefore only an apparent one. The methods have changed. But today, as before, the results of the different expeditions are based upon the results of previous ones. If the modern explorer succeeds in making new discoveries he only pays the debt of modern times to the generations which have disappeared." [1]

Sobering contrast ... natural with those in social science

Yet hopeful prophecies must not forget one sobering fact. It is clear that the achievements of reflection have so far been most marked in increasing man's control of material things, transforming physical nature into his servant, and giving him a degree of comfort, leisure, and prosperity that a few generations ago would have seemed incredible. Even these blessings, however, have not been democratically apportioned, and it is distressingly evident, with the Great War still vivid in memory, that these tremendous powers can be used for evil ends as well as good. Shall reflection be able to achieve results comparable to these in the realm of human relations? Shall human engineers arise to vie with Galileo and Newton in brilliance, by discovering laws which can be dependably used to assure that everything good discovered by one shall promote the highest happiness of all? Such is the supreme need of our day, if civilization is to advance without an appalling setback. Reflective thinkers have the opportunity to perform a kind of service and

[1] *Chicago Daily News*, June 3, 1926.

gain a kind of renown that is both far more difficult to achieve and deserve than any other, but also more contributory to the greatest ends of human life. It is largely with the hope that earnest students will find a study of the principles of right thinking serviceable in equipping them for such vital tasks as this challenge implies, that the present volume is written.

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*Part II*

# THE GENERAL CONDITIONS OF RIGHT THINKING

CHAPTER FOUR

# ANALYSIS OF A UNIT OF REFLECTIVE THOUGHT

The task of Part II

THE three previous chapters sought to distinguish the different experienced facts to which the term thinking is applied, to locate particularly the kind of thinking which can be right or wrong, to determine the importance of right thinking in the light of its evolution, to reveal the main factors which lead it astray or make us content with many untested and inadequate beliefs, to exhibit the elements in human nature which support critical reflection, and to show some of the processes by which such reflection, once functioning, assumes the form of the institution whose one purpose is to establish dependable beliefs by the method most appropriate to that end—science.

Our next and central task is to investigate systematically the conditions of right thinking. Learning by reflection is in the main, as we have seen, the prerogative of man as man, and to study logic therefore as the science and art of right reflection is to seek to master and perform well what all men must do either well or ill.

Temporal analysis of a unit of reflection

To pursue such a systematic investigation we need to analyze typical examples of reflective thought in order to break it up into its distinguishable steps. These we can then examine in detail, and it will be found more thorough and instructive to determine the conditions of the correct performance of each of these steps taken successively than to attempt to discover them by merely viewing the process of thought in bulk, so to speak. As elsewhere in science and life, what is hard to understand and control in the mass becomes easier to master when broken into parts, particularly if these be temporally related. We owe it to Professor Dewey in our own day that such an analysis is now available. Earlier logicians had made contributions, but

it is he who for the first time has given an empirically verifiable analysis of an entire unit of reflection as it actually occurs in the experience of a thinker. The analysis breaks up such a unit of reflection into five steps stated in their natural temporal order. We shall not use Professor Dewey's own terminology entirely in the description of these steps, and at one step we shall introduce an important change, but to note the essential character of each of them is his great contribution to our study.

Step one —occurrence of a difficulty

The first step is the *occurrence of something which is felt as a perplexity*. As we saw in the first chapter, all of us much of the time, and some of us almost all of the time, are engaging in other types of thinking than that which aims at the establishment or use of a true belief. We are pursuing a congenial reverie, or absorbed in pain or enjoyment, or passively acquiring information, or doing something else which does not involve intellectual effort under the guidance of a definite need. Some stimulus, accordingly, must occur to recall us from such spontaneous activities and impose on us the necessity of winning and using a correct belief about certain facts—either facts about which we have hitherto had no definite opinion, or ones as to which we have now been given reason to distrust our previous opinions. This stimulus is usually some event external to the play of ideas in which we have been engaged, as when familiar and habitual performance meets a block which checks it until we have reflectively thought out some way of completing it in spite of the handicap met. A housewife used to cooking by gas in the city, faced with the task of preparing dinner over an oil stove in a summer cottage, will meet such checks frequently until new habits have been formed. Or a novel event will excite our curiosity and lead us to seek an explanation of it, or perhaps to make it a means to some hitherto baffled purpose. This may take the form of observing something which constitutes an exception to some hitherto accepted belief and induces us to reconstruct our opinions on the matter in question. One of the lessons of Part I was the desirability of forming the habit of being constantly alert for such exceptions, and of

being always ready and eager to engage in the reconstruction required in order that our beliefs shall accord with fact. But the stimulus need not be external. Especially in those in whom the habit of intellectual curiosity is formed and active, as the preceding point suggests, something occurring in the free association of ideas itself may suggest an interesting problem, or the mind may (after a period of relaxation) return spontaneously to perplexities which had previously baffled the effort to reach a satisfying answer. To be a philosopher is, among other things, to be caught in problems so comprehensive that almost anything is apt to suggest them, and so difficult that no solution is ever quite so satisfying that it involves no remaining challenge to thought.

The first step is described thus at length because we shall not hereafter recur to it except by way of illustration. The only way in which our thinking at this stage can be improved is the one indicated in the preceding chapter, namely, by forming the habit of seeing perplexities where other people do not, and of accepting the responsibility to think them through. Only thus can we contribute to the establishment of sound beliefs and secure the resulting values for human life. The essential point about it, factually considered, is that something happens to recall attention from nonreflective modes of thought and focus it upon some difficulty which we feel the need of solving.

Step two—clarification of the difficulty

The remaining four steps we shall at present characterize as briefly as possible, since we shall need to examine each of them in greater detail in subsequent chapters. The second step consists in *observation, designed to make clear precisely what the difficulty is.* It localizes it at some particular point in space or in some specific object or part of an object, or (if it be not the kind of problem that can be thus spatially localized) it describes more definitely its nature. In practice it often takes the form of bringing together in observation the facts which explain just why the problem is a problem. This brings out the characteristic difference between the second step and the first, in which the problem is vaguely felt as something challenging

thought, but in which the definite facts which make it a problem have not yet been clearly noted and brought together. To exemplify this in a very simple case—suppose I am walking along a road not far from the lakeside, and notice a path branching away from it which I had not previously known to exist. Thought is quick—so quick that it is often very difficult to separate clearly the distinct steps it reveals—yet one can distinguish the mere feeling of a challenging novelty on seeing the path from the question which immediately springs to mind: "Where does it lead?" With this question I am in the second step; it clarifies the difficulty and makes precise just what I want to find out. Behind it lie the rapid observations that here is something new, that it is a path, that it leads to some place which people wish to reach. These are the simple facts which, together with a bit of curiosity in my nature, explain why the experience is a problem and why the problem takes the form that it does.

This clarification of the difficulty is itself, of course, a temporal process, and could be analyzed into still smaller parts if anything of value for logical study could be thereby gained. We may simply note in passing that in general it is a process whereby we advance from broader and more general questions to more localized and specific ones. That is, we first recognize the general type of problem which must be dealt with, and then gradually narrow our observation, trying to grasp more and more clearly the specific features which differentiate the difficulty from other similar ones, and which must be adequately taken account of if a solution which is relevant to just this difficulty is to be reached. Thus in the case of our suggested illustration, we first recognize the general nature of the puzzling object as a path, and then proceed to note what special characteristics it shows which have made the question of its direction a challenging difficulty. But the same conditions of correct observation which it is important for logic to note apply to both general and specific aspects of this process, so we need not multiply the details of the analysis.

The third step is the *coming to mind of suggested solutions of the difficulty*. To continue with our illustration, the thoughts quickly occur: "Perhaps it leads to a spring," "It may be a short-cut to another part of the road," "It may lead over to the lake." What is the source of these suggestions? As the preceding chapters show, it is my previous knowledge about paths, roads, and the general nature of the environment in which I am. That is, here is an instance of the reflective recall of memory-ideas reached through earlier analysis of objects and relations, selected and put together in new forms through the constructive use of imagination.

Step three—appearance of suggested solutions of the difficulty

We can entertain no suggestion which, at least in its elements, has not been derived from our previous experience as observed, analyzed, and retained in memory. This important fact we shall have occasion to revert to later.

The fourth step consists in *reasoning out, by the aid also of memory and imagination, what consequences are involved in the suggestions thus entertained, and evaluating the suggestions by their aid*. In simple cases the development of these consequences is performed so rapidly that it requires practice to see that it is actually there. When expressed in words, it frequently takes the form of a conditional sentence whose first clause is introduced by the word "if" and which supposes the truth of the suggestion under consideration, the second clause being introduced by the corresponding particle "then." Let us pursue the illustration on which we have been engaged. "If the path leads to a spring," I say to myself, "then there will be indications of a stream of water near, and of the use of the path to carry water." I may at this point advance to the fifth step, though very likely as I do so my thought will be going through the same "if . . . then" process with the other suggestions. "If it is a short cut to another part of the road, then there will be a wide turn in the road soon;" "If it leads to the lake, then it will have the appropriate direction and there will be signs that bathers have come and gone by it." What is the source of our ability thus to imagine the consequences implied in the suggestions which occur to us? Clearly, again, past

Step four—reasoning out the consequences of the suggestions

experience in the form of analytic observation of the relations of objects and events, retained in memory and recombined in imagination. Such regular relations, repeatedly experienced, have thrown the suggestions I am able to entertain into an ordered pattern, so that each element in the pattern has meaning in terms of definite connections with the others—becomes, in short, a *sign* of the others, justifying me in expecting them whenever it appears. Thus the suggestion of the path as a shortcut to another part of the road *means* a wide turn in the road; it is part of a system of geometrical relations implying such a turn in the road as another part. The idea that the path leads to the lake *signifies* a certain direction and its probable use by bathers in precisely the same way. It is our ability to possess meanings in this way and to reason out the significance of experiences in terms of their consequences, that makes it possible for the fumble element inevitable in all learning to be transferred in man (in part, that is) from overt action to imagination. It is what is meant, or ought to be meant, by the distinction of man from the other animals as the possessor of reason.

Distinction between problems requiring a fifth step and ones which do not

Now at this point we must make a distinction between two types of problem, a distinction which is important because with one type the act of thought terminates with step four, while with the other a fifth step is quite essential.

The reader will remember from the preceding chapter that it is fundamentally because a perplexity is painful that we seek to get out of it, and because the imagined solution promises satisfaction that we desire it and seek to attain it. Accordingly, this desired satisfaction in the resolution of the perplexity controls the ensuing process of reflection at every step—in the second step it is the clarification of the difficulty in the light of the kind of solution we want that takes place; in the third it is the suggested solutions that most closely harmonize with our dominant desire at the time that first occur to our minds. Certain aspects of this fact will help us at an important point in Part IV. What is the corollary of this constant control of reflection by the desired solution with reference to step four?

The answer is that it explains the number of the suggestions that are considered and developed, and which suggestion is selected as the basis for the resulting action.

If the bearings of the first suggestion that occurs to my mind all seem to fit the conditions of the problem, I shall be apt to select this suggestion as a guide to further action without considering others, except in so far as frequent disappointment in following first suggestions has inculcated the habit of inhibiting action till alternatives have been imagined—so far at least as time permits. If, however, some deduced consequence of the first suggestion is palpably out of harmony with the desired solution, I will, if immediate action is not imperative, consider and develop other suggestions to compare with it, until one appears whose imagined consequences are sufficiently promising, at least in relation to the others and to the time available, to lead to further action in accordance with it. This is illustrated in the above case by my proceeding at once to observe whether there were indications of a stream of water near the path before considering other suggestions as to its direction. But the main point at present is that, whether the first suggestion leads at once to action after its development, or is compared with other alternatives, the desired solution controls the entire imaginative process and determines the selection made—it is the suggestion appearing satisfactory or as the most promising of available alternatives in terms of this desire that is the one followed.

Now in certain types of problem this commitment to action in accordance with the suggestion selected on account of its developed bearings, terminates the act of reflection—in these there is no fifth step.[1] These types are mainly two. On the one hand there are the theoretical problems which do not need to appeal to verification in terms of empirical fact, but which are solved merely in terms of abstract relations deductively developed, such as the problems of pure mathematics. It would clearly be absurd to appeal to external observation or experiment to determine whether five plus five is equal to ten.

[1] The facts seem to me to require this modification of Professor Dewey's position.

We see that the relation must hold as a result of the very meanings of these numbers. On the other hand, there are the practical problems where, as is often the case, the time available for reflective guidance is limited, and where, accordingly, the action decided upon is final so far as that particular situation and problem is concerned. If the decision does not pan out well, we cannot recall our action and put ourselves in the same puzzle once more. This particular reflective act is past; the lesson learned will help in the clarification of future problems, but will not reinstate this. Later in the chapter we shall illustrate both these types.

But in other problems the action thus entered upon is a part of the reflective act itself, which accordingly does not terminate until a fifth step is completed. These comprise some practical problems and all the theoretical problems in which we are trying to understand some fact or facts which can be empirically observed or manipulated, something that can externally be pointed out to others. This means any problem which aims at the satisfaction of curiosity; it includes, among others, all the problems of the sciences except the science of pure mathematics. In these we are not trying to decide what to do under temporal pressure, we are trying to grasp something that happens in terms of its universal, dependable relations. If we fail to reach a verified solution on this particular occasion, we can still hold the same problem in mind and engage in further observation or experiment at another time. It is not tied down to any specific situation, but is held in abeyance till the appropriate action in the form of empirical observation or experiment has proven some suggested solution. The illustration which we have been pursuing is of this type. Clearly, the suggestion that the path leads to water cannot be reflectively adopted as proven in any sense unless its consequences can be discovered as empirically present.

Step five —empirical verification

The fifth step, then, in problems of this kind, consists in *observation or experimentation to test by empirical fact the suggested solutions in the light of their implications as thus developed.* The third and fourth steps constitute what (in terms

of our ordinary distinction between the mental and physical) we should call the peculiarly mental part of the process—that is, they could be performed, as far as their essential character is concerned, with one's eyes shut or even when removed from the physical context of the difficulty. With the fifth step the mental and the physical become united once more, as they were in the first and the second. We look to see whether the consequences signified by the suggestion are present or not, and we engage in such activities with hands, feet, or head as will enable the observation to be more easily done. Where such activities take the form of manipulating objects so as to force them to reveal facts not otherwise noticeable, experimentation is the proper word. In the simple case which we have been considering experimentation will probably not be needed. I reach the entrance to the path, my observation guided by the implied consequences which I have been reasoning out. No sign of a stream of water yet, and there is no turn in the road as far ahead as I can see. I follow the path to the top of a little knoll. Still no sign of a spring, but I see that the path advances in the general direction of the lake. I scan the path more closely. In the firmer soil a few feet farther on there is the print of a bare foot. A child's? No, it is too large. A conclusion to the entire act of thought now thrusts itself irresistibly upon me. The path leads to the lake, and is used by the cottagers across the road when they go bathing. That is, the consequences signified by the idea that the path leads to the lake I now find to be observably present in fact, whereas the consequences of the other suggestions are not present. I say, therefore, that the idea that the path leads to the lake is proven, or verified—it constitutes a true, or right, or correct belief. Of course this does not mean that I might not by further investigation find the belief mistaken. Though clear as far as it goes, the evidence is rather meager and is possibly compatible with some other destination of the path. But I do not propose to carry my investigation further, because it is not important enough for me at present to have an absolutely certain belief about the matter; it is hardly worth my while to seek clearer evidence.

It would be just about as easy to follow the path all the way through. In other words, by saying that my idea has been verified and that the belief reached is right or true, I often mean simply that it is true enough to serve as a basis for whatever further thought or action might be stimulated in me by the existence of the path. Were I a scientist engaged in establishing beliefs which should be as thoroughly dependable for any purpose as the present tools of investigation make possible—in this instance, let us say, a surveyor engaged in making a careful map of the region—I should not allow myself to be satisfied with such a rough and ready result. Then it would be my responsibility to survey the course of the path fully and to chart its relations with surrounding points of interest so that everybody who used my results would find in them sure and definite guidance.

**A practical problem in which step five is present**

Let us take now as illustration two cases of adapting means to some practical end rather than the satisfaction of curiosity, in one of which a fifth step may be present; in the other not. I am repairing a weakened window, in the course of which I find it necessary to build a new frame for it. When nearly through making the frame I run out of the one-by-four material which I have been using for the facing. This sense of block or check in achieving my desired end constitutes, of course, step one—the occurrence of the perplexity. Since, in such a situation, all my activities are coördinated in the pursuance of a definite purpose, it is but a slight passage from the first sense of bafflement to the clear formulation of my problem in the light of that purpose—the second step. How shall I finish the frame? Observation thus clarifies the problem simply by noting the relation between the check and the controlling purpose. Suggestions now arise. Shall I use a piece of wider material which I have? Before a second suggestion has time to appear I have already gone through the fourth step with this one, for a consequence which leads me to reject it comes to mind at once. If I do that the facing will have a crude look, and it will be worth a little more effort to have material of the proper width. Since this is incompatible with my larger purpose in making

the frame, I reject the suggestion. Now others occur. Shall I order another piece of one-by-four? Again implications come to mind which lead me not to reject it entirely, but to postpone the suggestion till I have considered others. It would take time to get it, and now I am at the job I want to finish it. Shall I walk over to my neighbor's, who has just been doing a little building, and see if he has not left a piece long enough for my need? But that would take a little time, too, and I am not sure that he has been using just this size of lumber. While I am hesitant as to whether to carry out this suggestion, my eye lights on the larger piece I had first considered (that is, I return to step two and expand my observation) and a further idea appears. Why not cut it down to the right width? The grain is straight. I could split a strip off and plane it down in a few moments. I weigh the implications of this suggestion rapidly in the light of the available alternatives and the decision to act upon it sets me to work on the piece in question. Now in this case failure would probably not introduce me to a quite different problem. If it proves impossible for me to finish the frame with the wood in question, I still have the other alternatives to fall back upon; it is not necessary to finish the job within any specified time, and presumably I should prefer one of the other alternatives to leaving the entire task unfinished. Knowing this in advance, my use of the present strip of wood is of the nature of an experiment. It will test a certain suggested solution of my problem, but if it fails, the same problem may be solved in other ways.

One in which it is absent

Contrast with this another practical situation. I have to meet an appointment downtown in three-quarters of an hour. What means of transportation shall I take? As possible solutions are suggested the bus, the street car, the suburban trains, and the elevated. Developing the bearings of these in the light of my past experience of their speed and my knowledge of their relative distances at each end of my trip, I decide, let us say, that the elevated is the most likely to take me where I wish to go in time. But once I have acted on this suggestion and boarded an elevated train, or even taken a few steps to-

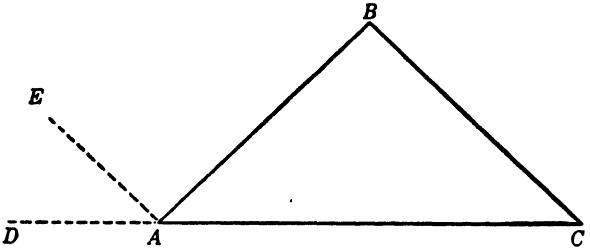
ward the station, I am completely committed as far as this problem is concerned. The other alternatives are no longer available, for now it would be quite impossible to arrive in time by using them. This act of thought, then, controlled by the need of solving this problem, terminates with my action on the suggestion of the elevated. If the choice proves to be unwise, I can use the lesson thus learned in other problems in the future, but this specific difficulty will be over. The action embarked upon in such a situation, accordingly, does not verify any suggestion and is no part of the act of reflection; for the problem was a practical one with a definite temporal pressure, and the suggestion was not that the elevated would bring me to my destination by a specified time, but simply that I had better take it. There is no way of empirically verifying that suggestion. The action is subsequent to the thought, not a part of it.

Illustration of thinking in pure mathematics

At this point it will be well to exemplify also the type of theoretical problem in which there is no fifth step. This type is coextensive with pure mathematics, using the latter phrase in its broadest sense. Here the guiding purpose in the problem is simply to discover certain hitherto unestablished relations between general concepts such as numbers or geometrical figures, without any reference to the physical objects to which these concepts might be applied. In the solution of these problems the fourth step is accompanied by physical activity—drawing of figures, jotting down of equations, etc.—but this activity is merely a symbolic aid to the conceptual process; it is not comparable to the kind of observation or experiment that constitutes verification of the elaborated suggestions. Let us imagine ourselves as students beginning the study of geometry.

Having mastered the simpler properties of parallel lines in relation to an intersecting straight line, we find ourselves asked to prove that the three angles of a triangle are equal to two right angles. Our problem thus defined, we consider various suggestions of ways to solve it. These will take the form of ideas symbolized by constructions added to the triangle such as might carry implications that would establish the theorem.

Doubtless several such ideas occur and are followed up in vain before the suggestion comes to extend the base of the triangle AC to D and see whether the external angle DAB cannot be shown equal to the two internal angles ABC and ACB. For, since DAC is a straight line, angles DAB and BAC are together




equal to two right angles. Remembering now our theorems about parallel lines, we construct AE parallel to CB. Further implications at once appear. Angle DAE equals angle ACB, being the exterior interior angles produced by the intersection of parallel lines with a straight line. Also angle EAB equals angle CBA, being the opposite interior angles. Therefore we proceed, angle DAB equals the sum of angles ABC and ACB, and the straight angle DAC equals the sum of angles ABC, ACB, and BAC, the three angles of the triangle. But, as a straight angle is equal to two right angles, this is what we had to prove.

Now every part of this demonstration, subsequent to the occurrence of the fruitful suggestion, belongs to the fourth step of the act of thought. It is simply the development of a series of implications about the external angle DAB, analyzable into a chain of deductive reasoning. Since the purpose of solving the problem controls the whole piece of thinking, the concluding realization that these implications have reached a result that satisfies the original condition, is no external addition to the development of the implications. It is simply the consciousness that the purpose has been achieved and the perplexity solved.

If we were mathematical geniuses discovering this theorem for the first time, the situation is not altered in these fundamental respects. The range of suggestions and implications will be

Mathematical discovery

wider, but again such physical activity as is undertaken will be an aid to the imagination merely and will not constitute an additional verifying step. Here our guiding problem will at first not be so definite. We shall be playing mentally with the conception of a triangle, interested in seeing what novel relations can be shown to hold about it. In time the thought occurs that perhaps its three angles are equal to two right angles. Since this has not yet been proved, it constitutes a problem. Suggestions then occur of various constructions on the triangle whose implications might harmonize with this hypothesis. Doubtless many constructions would be tried and their implications followed out, before the attempt is made to extend the base and construct a line parallel to the opposite side. But when that construction has been tried and its bearings developed, if the relations of parallel lines form a part of already established knowledge, it will not be long before a point will be reached at which it will be seen that the original suggestion has been proved. But again this realization is but the expression of the purpose which has been controlling the thinking all along. It can hardly be regarded as an additional step.

With a little practice the student will find it easy to take any isolable unit of reflection from his own experience and subject it to a similar analysis. The following have been found, in the writer's experience, the chief difficulties which in the case of some stand in the way of ready mastery of the analysis.

**Certain questions about the analysis answered**

(1) The difference between steps one and two is primarily a difference between the occurrence of the stimulus which involves one in the perplexity, and the clear statement of just what the perplexity is. Psychologically, this corresponds to the difference between vaguely feeling that one is in a difficulty and formulating exactly what one wants to do. Sometimes, of course, the two steps merge completely. This is the case where the problem is given us at once in its precise formulation, as when we are assigned an original theorem in geometry or commissioned a specific errand by our employer. In other cases a distinction can be noted.

(2) There is a temptation sometimes to regard steps two and three as merging, where the problem is such that only two or three alternative solutions seem possible. Shall I go to class this morning or cut? seems like a precise statement of the problem as well as of the suggested solutions. But the two processes are very different and they must not be confused, however closely they may sometimes be connected. In this case the problem as clarified in step two probably was, Shall I go to class this morning? arising because of some stimulus which makes the accustomed routine distasteful. Step three will accordingly consist in facing the two alternative possibilities, (a) I shall not go, (b) I shall, the consequences of each of which will be developed in step four.

(3) Those whose thinking is very concrete will tend in their own reflection to pass over steps three and four so rapidly that they find it difficult to isolate them and identify them constantly, particularly in the case of step four. It will help if we fix firmly in mind just what these steps accomplish. Step three is the coming to mind of possible solutions of the problem, step four a reasoning process in which the consequences bound up with these suggested solutions are followed out mentally. The latter can always be expressed in the "if . . . then" form of complex sentence. The dividing line between steps four and five in problems where a fifth step is necessary is the line between *thinking out* what ought to be a present fact if such and such be the case, and *looking to see* whether it is a present fact or not.

(4) Finally, a misunderstanding of the temporal relations of these steps must be avoided. They always succeed one another in the order named, in the sense that suggested solutions do not occur till the problem is sufficiently clarified to make them possible, nor can the implications of a suggestion be reasoned out till the suggestion itself has come to mind, etc. But the student must be careful not to suppose that a given step is over and finished when the succeeding one begins to function. The cases where this is so are the exception rather than the rule—they are the simple cases where the first suggestion

that comes to mind seems to afford at once an adequate way out of the difficulty. In most cases (and the examples given earlier in the chapter are of this sort) the process is somewhat more complicated. As soon as the problem is clarified sufficiently for a suggestion to emerge, we accept it and follow up its implied bearings. If these seem favorable and are such that observation can readily test them, we pass at once to the fifth step. If the suggestion is there rejected we return to the third step and try to get another suggestion, or if this is difficult without further clarification of the problem we go back to the second step. Then the same process is repeated. Often, however, the observation or experimentation required in the fifth step takes more time. While we proceed to carry it out, further suggestions occur and their consequences are developed. If one of these seems more promising, or can be quickly tested, we follow it through to the fifth step, abandoning the earlier one. Sometimes a continuous series of observations can be made, or experiments devised, which will test together a number of different suggestions. The most interesting experiments in scientific history have been of this sort. Oftentimes, moreover, steps two and five will merge together in the sense that an observation which disproves a certain suggestion may also clarify the whole problem in such a way that an entirely different group of suggestions arise. Thus the attempt to mend a piece of broken machinery by wire may, while failing, indicate that the break was of a somewhat different sort than had been supposed. Thought may thus trace its steps time and again while occupied with a given problem, until either some suggestion is hit upon which is found to furnish the solution or the attempt to solve it is given up as a bad job. But each step occurs in its definite place in the temporal order, in relation to the preceding steps.

The importance of Dewey's analysis lies in the fact that it is an empirically verifiable dissection of thinking into its temporally successive elements, which can be observed in their functioning in every isolable piece of thinking, and whose study, in the light of their functional relations, yields fuller understanding and control of the entire thought-process.

EXERCISE A. Analyze in terms of the steps of a complete act of thought a recent attempt in your experience to solve:

1. A practical problem under temporal pressure.
2. A practical problem permitting a fifth experimental step.
3. A theoretical problem involving empirical verification.

B. Solve the following cryptogram, and then analyze the thinking by which you solved it in terms of the five steps:

XLMW MW IEWC XS WSPZI.

C. Analyze in these steps the way in which you solved the problem: What courses shall I take this semester?

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CHAPTER FIVE

## RIGHT OBSERVATION—THE CONDITIONS OF RIGHT THINKING AT ALL THE STEPS

Conditions of right thinking in general identical with those of the second step

THE next steps in our task are, in natural order, to investigate the conditions of correct thinking which apply to all parts of this fivefold analysis, and then to describe the special conditions which hold for each of the last four in succession. Fortunately, we do not need to divide this program into quite so many separate units. For it happens that the general rules that hold for every act of thought considered as a unit, are also those that apply particularly to the second step—clarification through observation.

The reason for this is twofold. One consideration is to be found in the fact that the observations we make for the purpose of clarifying a present problem always represent the funded outcome of our solution of previous problems. That this must be true is clear if we remember that our statement of any problem must always be in words or ideas whose meaning has been gathered in the course of our past experience. When, in the example used in the past chapter, I perceived a certain interesting part of the landscape ahead of me as a path, and asked the definite question, "Where does it lead?" I was formulating a present perplexity in terms whose purport was fixed by related experiences in the past. Had I not known with some definiteness the meaning of the word "path"—that is, what kind of thing a path is—I could certainly not recognize this present fact as a path, nor could I ask any specific questions about it. We must be able to identify, in some general way, at least, the objects which form the foci of our problems, and guide our questions by some experience of what we may expect from

them, otherwise we shall be so completely lost in their presence that we could not even feel a perplexity. To be perplexed is to be in a situation some phases of which are new and therefore challenging, some of which, by contrast, are familiar, and therefore furnish clues in the form of stable meanings which enable us to define in some intelligent manner what is still needed to satisfy. An experience entirely novel would, so far from constituting a difficulty, be one of which we should never be conscious at all. Beyond producing perhaps a quite inchoate uneasiness, there is nothing in it which could operate as a stimulus. But since we are not born with a set of definite meanings in our minds, nor can they gain any live and usable form apart from a process of learning, they may be appropriately described as the funded product of the problems already lived through, existing in us now as a mass of intellectual capital ready for investment in new puzzles.

The second consideration is that when we view the step of observation prospectively rather than retrospectively, we find that it lays down the limits within which the following steps must function, and determines the atmosphere in which the entire act of thought will develop. Suggestions are entertained of possible solutions of the *problem defined in step two,* not some other problem, and it is the consequences relevant to this problem that are followed up in the fourth step and overtly tested in the fifth. Thus the succeeding steps cannot possibly be performed well if this has not been done well. And as regards the atmosphere or attitude revealed in it, it is surely to be expected that if one's thinking is hasty, impulsive, or careless here, it will be apt to be so throughout. For minds are not reformed suddenly in the middle of a reflective act.

Thus we may combine in the present chapter the two tasks noted in the opening paragraph. What are the essential conditions of good thinking in general which are also the specific conditions of good thinking at the second step?

(1) Good health

The first of these may seem to be a simple physiological matter, and to those who tend to regard mind and body as quite separate entities rather unnecessary. This is the condition of

*health.* Good general health is just as favorable to good thinking as it is to the efficient performance of any normal organic process, such as rapid elimination of poisons or restful sleep, and the same relation obtains between bad health and bad thinking. The traditional extreme dualism of our notions about body and mind has been so completely undermined by recent physiological and psychological evidence that it is no longer possible to draw any clear line between these two entities. As a matter of fact, as far as our present point is concerned, this inherited dualism has always been sufficiently out of touch with common experience for us to abandon it whenever practical matters are at stake. We know full well that we cannot perform arduous intellectual toil when suffering from the toothache—simply because the local pain constantly attracts our attention from the problem in hand—and one of the signs of a resilient condition of the organism generally is an unwonted rapidity in the flow of ideas and a surer grip on the conceptions which we have been struggling to make our own. But there is a more precise scientific basis for the relation here affirmed. The health of the entire body is uniquely dependent on the efficient functioning of the nervous system, in that every organ is regulated as regards both its muscular and glandular activity by reflex arcs linked through the spinal cord or the lower centers of the brain. A condition in which these organs are functioning poorly signifies that the controlling nervous mechanism is not working smoothly, and more nervous energy must be drawn to enable them to play their part adequately in the life of the organism as a whole. All the evidence available points to the conclusion that it is the higher centers in the brain that are exercised vigorously when active thinking is going on. But rapid metabolism there cannot take place so well, nor be continued so long, if an unhealthy condition elsewhere requires a more than normally rapid replacement of tissue. It is precisely the same principle that is noticeable whenever we try to think hard after a hearty meal, and find that either the stomach quite refuses to surrender the extra energies required to handle its unusual burden or else if we do succeed in con-

centrating on the intellectual task, our dinner remains largely undigested till we give the mistreated organs a chance. Other things being equal, he thinks best whose entire organic life is in tune with itself and its surroundings to the highest degree.

There are, of course, apparent exceptions to this rule. Some of the greatest scientists, philosophers, and men of practical achievement have been in chronic ill-health. But their testimony seems to be quite unanimous that this was a handicap to large intellectual accomplishment and not an aid. Herbert Spencer, the great English philosopher of evolution, tells frequently of the rigid restraints which ill-health compelled him to impose on his life in order that the overmastering ambition represented in his *Synthetic Philosophy* might be fulfilled. What has usually happened in these inspiring cases is that we have men of high natural intellectual genius, whose insistent self-discipline enabled them to forego pleasures which men of better physique would not have surrendered, in order that the high attainment in the world of thought toward which they most earnestly aspired might become theirs. Moreover, ill-health tends to distort thinking as well as to check it. The melancholy produced by continued disease is projected into the universe at large, and cynicism, intolerance, or wild fanaticism are hard to correct while inner distempers remain. All dissociation is probably organic at bottom. The man who is consigned to an insane asylum we have come more and more to view as simply sick in a definite way, not possessed of demons who are to be exorcised by violent punishments. Or the distortion may take the form of a morbid preoccupation with an envisioned realm of eternal rest and freedom from the sighing and pain that characterize this "vale of tears." Hands are folded in the face of present ills in the sickly hope that we shall somehow in time be magically transported to a better realm, whereas the healthy man's normal impulse is to translate his ideals continually and fruitfully into socially effective goods, and let the lessons learned in such activity react to modify the ideals themselves in the direction of fuller pertinence and power.

(2) Command of available tools

The second condition of good thinking in general and effective observation in particular is command of the best tools that human experience has made available in the clarifying observations and resulting definition of the problem. He is under a terrific handicap in trying to thrash his way through a challenging puzzle who is not able to use to the full the most helpful instruments that have so far been forged in the course of humanity's struggle to achieve its goals. Others better equipped than he will outstrip him, and he will find in time that much energy has been wasted that a more varied and dependable knowledge would have applied toward definite results. "Knowledge is power," was the gospel with which Francis Bacon ushered in the modern age. It is power, because the larger the element of familiarity in the perplexing situation, the more definitely can the precise nature of the problem be located, and, as we shall see in succeeding chapters, the more varied and relevant suggestions brought to light, and more certain implications developed.

These are in part intellectual

These tools are of two sorts, intellectual and mechanical. By the former are meant the ideas, concepts, terms, in which we perceive, recognize, define, and order the elements of our experience. As we have seen, all our problems have to be formulated in the meanings fixed by these tools; we cannot proceed in thought at all without using such tools as we have, and in the best way we know how. But it makes a vast difference whether the best way we know how is also the best way available or not.

We have here the fundamental reason for education on its informative side. In the matter of technical education, for proficiency in the skilled trades and professions particularly, the principle is now popularly recognized. "Get the man who knows," is a slogan that in questions of practical concern is generally respected. This is not universally the case, of course. In the most important profession of medicine, for example, quackery still abounds, and hosts of people turn to magic of one sort or another rather than to science. Yet there is a good deal of excuse here in the fact that scientific medicine is still so much in its infancy that there are many, many matters on

which no clear laws for remedial guidance can be formulated at all. Where practical pressure is strong, and dependable knowledge available, no argument is now needed for its importance. But the principle is quite universal. Whatever problem we face, and whatever type of solution we want, if we have at our command the best knowledge available on the field in question, we shall be better able, other things being equal, to locate by observation the facts that are really relevant and to state the problem in the most promising terms. Here again we come upon the central function of science, as supplying the best beliefs available at any given time on facts with which we need to deal.

In part mechanical

As regards the mechanical tools in addition to the intellectual, it is of the first importance to recognize that in the history of science they have been equally necessary. Without them such observation as we engage upon must be done with our unaided senses, and these at best are quite unable to reveal many of the facts that are crucial for adequate diagnosis of our difficulties. Primitive man develops his senses to exceeding acuteness compared with civilized man; by keen sight, hearing, and smell he can detect signs of an enemy or intimations of prey quite imperceptible to most of us, and follow swiftly and noiselessly a trail which would be nothing but unbeaten forest to us. But the limits to fruitfulness of observation in this direction are quickly reached. For the facts which often need to be brought to light for the proper statement and solution of our puzzles are quite beyond the reach of anything but an exceedingly delicate instrument. Increasing recognition of this fact has led civilized man to invent finer and finer tools to supplement the testimony of the senses, and to abandon (except in special situations) the attempt to rival the savage in the keenness of the tools which are nature's gift. The history of science could be written most illuminatingly in terms of the progressive invention of more subtle machines for fuller sense observation. The story of modern astronomy is largely the story of the telescope, beginning with the simple tube and lens with which Galileo startled his generation by announcing the mountains on the moon, the

phases of Venus, the spots on the sun, the satellites of Jupiter. The story of modern biology is largely the story of the microscope, by which for the first time the minute structure of living matter was revealed, and by whose development the most momentous discoveries have been made in the age-long struggle with disease. And the point could be equally well exemplified from every science. A large number of these instruments are, of course, instruments of measurement. This is shown by the suffix "meter," with which so many of the names of our technical instruments end: exact observation means observation not only calculated to bring out the hidden facts that would otherwise not appear, but also to reveal them in their quantitative ratios —how much there is of each. The relation of this to the mathematical aspect of scientific history is clear in general; its detailed significance we shall postpone for the present.

Their importance illustrated

A single illustration of this theme will be sufficient. Suppose a doctor were to attempt to diagnose a serious case of illness with none of the tools invented by science to aid him in the task. The man has fever, perhaps, but the doctor has no thermometer to measure it, he must needs guess the best he can by the mere feel of the man's forehead to the palm of his hand. And his judgment will inevitably fluctuate enormously because the temperature of his own hand changes with all sorts of external factors. The lungs are perhaps in the last stages of decay, but he has no X-ray to apply, no stethescope even to aid him in judging their condition. He can roughly count the pulse and look at a specimen of the blood, but he will not be able to see what vitally needs to be seen. If typhoid bacilli happen to be disporting themselves in the blood stream, he will have no means of discovering their presence. The blood pressure may be dangerously high, but he will have no means of testing it; vision may be distorted, but he cannot tell how much; serious chemical changes in the products of the liver, kidneys, and other glands may have taken place, but he can only crudely conjecture them if able to entertain such a suggestion at all. Should an operation be needed, his instruments are those of a primitive carpenter, and he has no way of making the operation painless

nor of guarding against infection. The catalogue could be continued almost endlessly. We have only mentioned the most prominent general possibilities and the most popularly familiar medical instruments.

But this would be only a part of his plight. Parallel to the lack of mechanical instruments, there would go the same terrible lack of the appropriate intellectual instruments in terms of which to go about his task. He would have no conception of infection, because the causes of infection are beyond his ken; he would have no idea of the possibility of many of the most critical diseases, such as typhoid fever, because the underlying key to such a complex of symptoms, the presence of bacteria in the blood stream, is something of which he has never dreamed. Nay, even the notion of disease itself—that is, of a group of symptoms related together by some underlying fact which is the heart of the whole trouble, and curable by a single line of organized attack—would be absent. The history of medicine shows that the earliest civilized doctors, among the ancient Egyptians, treated what we should call the symptoms of a disease rather than the disease itself. That is, there was one remedy for headache, another for chills, a third for fever, a fourth for quickened respiration, etc., all of which were applied without any reference to one another or to any central condition as their cause. The reason is simply that nobody had yet thought that there might be any such central causal condition. Even the practice of recording the history of a case, so as to suggest laws of the temporal development of typical diseases, did not appear till the time of the Greeks. It is not too much to say that a modern doctor would feel a total helplessness could he picture himself reduced to this level in the history of his science. He would see little value in having such doctors at all.

**Popular violations of the**

The corollaries of this for the history of science are exceedingly interesting, but they do not concern us at present. The point now is that an essential condition of the best thinking is command of the best available resources for seeing the precise nature of the problem which thinking faces, and for stating it

in the way which experience with related problems shows is apt to be most fruitful. Few doctors today would dare to practice without a fairly adequate knowledge of at least the main principles and applications of their science and the possession of the most constantly needed instruments; and they would know to whom to send a patient for the more specialized diagnosis in which they were not expert. But in the fields where exact knowledge is still less established than it is in medicine, or where suffering is not so directly associated with the lack of it, the tendency still prevails to be satisfied with second-best knowledge, or even with nothing but a quite haphazard guess. In politics or morals, for example, people often resent the mere intimation that there might be knowledge on such matters that they do not possess and which might make a vast difference in their method of dealing with such problems. To learn that there are clearly formulated plans of proportional representation, for example, that would at once eliminate the main evils of group or minority rule, and which merely wait to be put in effect, is a quite startling lesson to many. Everyone who wishes to be a good thinker must take the responsibility of equipping himself with a general knowledge of varied fields and a detailed knowledge of at least one considerable branch of some field; he should know where to turn for knowledge on any type of problem which he himself lacks; and he must form the habit of raising the question before dealing with any important task, whether there may not be knowledge or physical tools available for help in attacking it which might make the whole situation far more promising. Unless the need of immediate action is very great or the matter of small importance, it is best as a general rule to spend some time in the search for such knowledge.

There is an important difference between individuals here as well. Where egotism and impulsiveness are strong, the tendency will surely also be found to commit oneself to action without any vigorous inquiry whether the knowledge of others might not furnish a most valuable addition to one's own; some men, indeed, would rather waste time and effort, or even give

up a problem unsolved, than meet it by following the suggestions of others. It is hardly necessary to remark that such tendencies must be fully overcome by one whose desire is to think aright. Thinking is a socially conditioned process, anyway—it is grotesque indeed to attempt to live on one's personal intellectual capital.

But in the third place, it is vital to recognize that the best knowledge of the past may still prove to be inadequate. We always clarify and define our problems, at first, in terms of such knowledge, but continual bafflement may force us to entertain suggestions that go far beyond anything that the best information so far available would justify. If this possibility is held in mind at the start the character of the whole thought-process will be affected accordingly, and observation itself will become more tentative, flexible, and alert. It is suffused with an attitude which would otherwise be absent, the attitude of being ready to find what others have overlooked as well as what even the clearest sighted have bidden us to expect, and perhaps to make an original contribution such as would make it possible for those who follow us to attack their problems more hopefully than we have been able to attack ours. If we lack the equipment to carry the novel hypothesis through, at least we can pass our data and question on to those who are more able to test it. The reflective millennium will not have arrived till all men have thus accepted the responsibility to coöperate, so far as in them lies, in the advancement of human knowledge to larger conquests. The mere statement of such an ideal indicates how far we still remain from the intellectual paradise.

(3) — to correct the past

The example just drawn from the history of medicine enforces the importance of this condition of good thinking as much as it does the need of using at any time the best resources that are at hand. It is surely clear that if some of those whose lives were given to medical theory and practice had not carried on their thinking in this spirit, the best doctors today would be no more scientific in their methods or effective in their results than the Egyptian doctors were, or rather even the rudiments of scientific treatment which they reveal as compared with the

primitive medicine man would not have been gained. We are still, perhaps, in the merest beginnings of scientific medicine in comparison with what the future may be able to show, if the progressive attitude here described become at all widely diffused. To see every situation both in the light of the most competent knowledge and tools that men have yet devised to deal with it, and also in the light of possibilities that have not yet been made actual by any man—this is a hard combination to realize, but a vitally essential one if thinking is to maintain its highest level of effectiveness. There is always more to be learned from others, and always more to be found than they have found, about any significant object of human interest.

(4) Accommodating reflection to the available time

The fourth essential of good thinking at all steps and of step two in particular, is the habit of accommodating the time spent in reflection to the importance of the problem. This is a condition of the wise adjustment of thinking to the whole of life. The preceding considerations must not be interpreted to imply that whenever we face any problem we are responsible to achieve the best result that it is humanly possible to achieve. This would be quite fantastic. The general principle to have in mind is that there are some perplexities to which it is silly or worse to devote much effort, while there are others which deserve the very hardest application that we can give to them. As to how to tell which perplexities are to be placed in either class, no general rule can be laid down; it depends on the individual's situation, interest, and the responsibility to general human welfare under which his particular abilities lay him. Thus for me to spend very much time trying to find out how best to build a small flower garden probably would be rather foolish, for almost any arrangement of flowers gives me pleasure, and my main abilities and interests are of another sort. But the same would not be true of one whose garden was a veritable hobby, still less of the professional horticulturist whose accepted social task is to discover and teach the best answers to such problems.

Merely temporal considerations often play a decisive part in an act of thought. If my problem is to determine how to

spend an unexpected afternoon of leisure, it would obviously not be the part of wisdom to consume most of the afternoon studying over the question. It would be far better to give up the attempt to deal with the matter reflectively, and simply toss a coin, rather than let time decide in this fashion by negating all of the possibilities that would otherwise be open. Time will decide every question for us, if we do not decide it in some more intelligent way. And of course there are many difficulties which have to be decided very rapidly and which are so important that it is necessary to mobilize in whatever time is given the best thought at our command, even though its accomplishment may still seem very meager. Accident, or threat of accident, important decisions that have to be made by a certain time but which perhaps affect our entire future career, are cases of this sort. When they come our only resource is to bring to bear at once whatever knowledge and tools we can muster and leave the matter of thinking out a more fully defensible way of dealing with the issue to our hours of leisure—provided we survive. The scientist is in the happy situation of being able to take his time about every problem—thus the achievements of science gain stability and certainty. With the rest of us (and with the scientist, too, in his practical problems as an ordinary human being) problems usually come with a definite element of temporal pressure. To give the proper amount of time to the proper things is a difficult art, but it is so fundamental an art that every thinker must do his best to acquire it.

(5) The habit of tentativeness where time is not pressing

One more and very important condition of good thinking still needs to be described, and it connects naturally both with the preceding thought and with the discussions of Part I. While it holds true that it is just as silly to spend too much time on an unimportant problem as it is to spend too little on a really significant one, yet our inheritance from an impulsive race of animals leads us all too often to decide matters hastily when we are not pressed for time and the issue deserves far more intelligent facing. We hate suspense, and insist on having an opinion on any important matter that may be discussed, de-

spising those who restrain judgment till they investigate the matter further or wish to maintain an open and unprejudiced mind. The psychological causes of this have already been analyzed; the point here is that whenever it is clear that rapid judgment is not essential, and the matter of moment, it is desirable to have the habit of circumspection and delay. We should encourage ourselves to restrain too early suggestions from leading to action till the nature of the problem has been more fully clarified by more careful observation. The doctor who should allow himself to entertain seriously suggestions as to his patient's malady before his examination had been thorough and careful, would be a bad doctor and would soon lose the confidence of his patients. The principle applies everywhere. Suggested solutions will arise, even on a very meager observation, but it makes a vast difference whether or not they are restrained from leading to conclusions till the clarification has really been completed or not. Bad thinking is often made bad precisely in this way.

An illustration of contemporary interest to be considered in detail later will help at this point. Suppose we note that the percentage of citizens who vote at elections is gradually decreasing, and become concerned about the matter. There are in general three ways in which we may react to the perplexity. We may at once insist that something drastic must be done about it, and with naïve confidence in the omnipotence of law to accomplish whatever is to be accomplished, pass a regulation making voting compulsory. Or we may attempt to deduce, from general principles in which we have confidence about the relative interests of people, the depreciated value of the suffrage, formulate in terms of this deduction what seem to us the main causes of nonvoting, and devise a plan to combat the further operation of those causes. Or finally, we may, in addition to deriving such light as seems to be justifiable from these general considerations, embark on a detailed investigation of the facts about nonvoting, endeavoring to secure in them not mere percentages, but clues that if followed up by still more facts may indicate genuinely dependable reasons for the existing state of affairs

and ways in which they can be opposed without bringing on ourselves other evils. There can surely be no question as to which of these three modes of clarifying a problem is the one most likely to lead to a permanently satisfying solution. The first is the way of caprice, the second that of entire dependence on past ideas, the third alone reveals the open-minded readiness to refrain from conclusions for a while and engage in the most objective investigation that is possible. And since the matter is socially important and does not need to be settled on the moment, what justification is there for following any other method? The motto, "Take time to think," should be early and indelibly engraved on the mind of every child, and applied particularly to the moral, social, and religious problems on which we are most easily tempted to form hasty opinions on ill-clarified data.

The discussion of the chapter may be briefly summed up by saying that every step in an act of thought is well performed when it furnishes the conditions for the most successful performance of the next step. The five conditions here named are those which experience recommends as the most reliable rules for securing this end. Since step two gives the atmosphere for the entire act of thought and lays down the limits within which it is to develop, these supply also the special conditions of good thinking at that step.

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CHAPTER SIX

## CONTROL OF SUGGESTIONS—THE NATURE OF HYPOTHESIS

Dependence of suggestion on past experience

THE third step in an act of thought consists in the occurrence to the mind of suggested solutions of the problem as clarified in step two. This is an exceedingly interesting part of the process, and at first sight it often seems such a mysterious affair that little if anything could be done to improve it. We shall see, however, that while there is an aspect of it which in our present state of knowledge seems quite accidental and uncontrollable, the problem as a whole is not at all hopeless.

If we remember the way in which, in actual practice, the occurrence of suggestions is related to the clarification of the problem, we shall quickly see the most important factor in this process which is clearly within our control. Every idea accepted as helping to define the problem tends to bring with it other ideas that have been vividly associated with it, among them, through the part played by success and failure in fixing relations, ideas found effective in solving similar problems in the past. By a similar problem is meant, of course, a problem whose definition involved many of the same factors that we find in the present one. Suggested solutions being thus the resurrection of ideas from past experience, or a combination of such ideas guided by the manner in which familiar elements are combined in the problem at hand, it is obviously essential to good thinking at this step that we have at our command a large storehouse of ideas connected in varied and flexible ways. This is only possible through a rich and mature experience, well organized, and greatly enlarged by the assimilation of information from others. Mastery, in fact, of the best knowledge

already available on any type of problem, is the main condition of the occurrence of relevant and promising suggestions for a solution of such problems. New suggestions, ideas not drawn from past experience, are possible only in the sense that the results of analysis of past experience may be recombined in imagination in novel ways. Thus the total conception may be new, as that of a centaur, a mermaid, or a golden mountain, to those who first pictured them. But the elements must already have entered experience.

This dependence of step three on the possession of adequate and systematized knowledge has, however, already been discussed in the preceding chapter—as there shown, such knowledge is a fundamental condition of good thinking at all five steps. We shall here, therefore, merely note the way in which it functions in providing suggested solutions of problems, and turn successively to three other themes which are most profitably treated in the present chapter.

The unpredictable aspect of suggestion

The first of these concerns the seemingly uncontrollable element in the task of improving step three as it occurs in our thinking. That it is to some extent at the mercy of accidents is clear when we note on how many perplexing occasions the suggestion which later, in a more leisurely moment of retrospect, pops up as the only sensible way out of the difficulty, fails to present itself till too late to be of help. "If I had only thought of that in time," we say to ourselves in sorrow or disgust. Evidently in practice we have to recognize that our thinking is limited not merely by the range of our knowledge, but by the range of whatever part of it proves available when we need it, and the fact that not all relevant knowledge does prove available, on occasion after occasion, indicates that there are mysterious barriers between ideas born in the past and present perplexities, which make it impossible for us to be sure that the best solution we know (in the sense of possessing it in memory) will be suggested at the time we need it. The man who could find a way to break down such barriers would be fortunate indeed; his thinking would gain an assurance that the rest of us quite lack.

Variation of individuals in fertility and relevance of suggestions

It seems tolerably clear that people who are roughly equal with respect to their knowledge in a given field, vary very greatly in their ability to produce the appropriate suggestion at the right time. This variation is itself a complex matter in which at least two important and independent variables enter. On the one hand the mere quantity of suggestions occurring within a given time may vary from almost zero to a very large number; the flow of ideas stimulated by a perplexity may be so slow as to seem a mere trickle, or it may be so rapid as to constitute a veritable flood. In general, of course, the more rapid the flow of suggestions, the more likely is the individual to reach a solution of his problem, though there may be times when a thinker is so overwhelmed by the fertility of his ideas that he is unable satisfactorily to develop and test any of them. Again, people vary very greatly in the degree to which the immediate problem steadily controls the rise of suggestions and insures their relevance. With some, attention wavers or quickly flags even in serious situations, so that ideas appear which are of no value for the difficulty in hand. With others, concentration is much more complete and persistent, so that only when the problem has continued to baffle for a long time, does its control over the course of ideas relax and further effort at a solution be abandoned. In which of these directions lies the condition of fruitful thinking is clear enough without specific statement, although there is perhaps here too a danger that problems of minor importance may in some cases engross too much attention at the expense of more vital ones. Variation in these important respects doubtless depends, at least in part, on physiological factors, at any rate it rests upon innate and very elusive differences, which at present seem quite beyond the reach of conscious improvement.

Superiority in these respects constitutes genius

What we refer to by the rather vague term "genius" is probably more intimately connected with superiority in these respects than with anything else. A scholar of the rather pedantic type is a very different person; he commands as much, perhaps more, information, but he can only reproduce it freely in situations similar to those in which it was gained; and even then

it lacks the spark of imagination which might stir the mass into ferment and bring its elements into constantly new and suggestive combinations. The genius has precisely this latter ability, and when it is combined with wide knowledge and the patience for creative toil as of the artist, or for careful experimental verification as of the scientist, the man who possesses it becomes one who leaves his mark on the world's history. We see the same general contrast here discussed on a smaller scale in the drawing-room. The ready conversationalist, good at repartee, whose wit is always entertaining, is simply the fellow who in the common themes of polite discourse is always able to produce the right suggestion at the right time. Far at the other end of the scale is the rather dull chap whose imagination is so far behind that of the crowd that everybody else anticipates his ideas before they occur to him. This handicap makes him the constant prey of harmless jokes and condemns him to a rather subordinate office in a competitive world.

How important is such superiority?

Yet lest the importance of these accidental factors be exaggerated, it should be noted that some of the most magnificent achievements in human history stand to the credit of men who lacked high genius in the sense here defined, but managed to make up for their deficiency by willingness to engage in hard and persistent toil in the accumulation of knowledge and the following through of the suggestions that did occur, or occasionally by some other exceptional virtue. In statesmanship Lincoln and Cavour, in science Darwin, in literature Milton and Ruskin, in philosophy Spinoza and Spencer, are names which occur in this connection. Of course, with no appropriate suggestions at all these men would have been helpless, but they were not unusually fertile in new ideas; the source of their success lay mainly in the fact that they laid a solid foundation of knowledge so that when a few suggestions came they would be really significant. They were willing also to follow up patiently the suggestions that appeared, and devote years of labor and energy to the task of seeing them through. Such men are given their opportunity partly by the fact that those who are richer and readier in new ideas are under the constant

temptation to leave them half developed and thus useless till others have carried them further, or to use their power merely to startle their fellows and further personal ambition. The genius who is to stand forth on the pages of time must overcome such temptations.

The tendency to accept sugges-tions uncritically

The second theme which demands discussion in the present chapter is the natural human tendency to terminate the entire act of thought with step three, that is, to accept suggested solutions as true without adequate development and verification. We saw in Part I some of the factors which make it easy for us, at least in matters which are not of immediate practical concern, to accept uncritically the first plausible suggestion that comes to mind and thus terminate the rather unpleasant condition of suspense which is inevitable during the time that the answer is in abeyance. These need not be repeated here, but the strength of the tendency should again be recognized, and the lesson securely learned that with certain qualifications presently to be mentioned, the most fundamental principle of right thinking is the principle of insisting on adequate development and comparison of suggestions before they are accepted as guides to action, and the most fundamental habit to be formed is the habit of tentativeness—that is, of welcoming whatever suspense is necessary if the bearings of a suggestion are to be carefully reasoned out and the suggestion put to objective proof. The great human fallacy, the basic source of error in thinking, is the readiness to accept suggestions without proper testing, because they are emotionally congenial, because they are supported by tradition and authority, because we are lazily content with half-lies, or for some other quite illogical reason.

Before developing this thought positively by a discussion of the meaning of hypothesis in science, let us note the qualifications above referred to.

Justified when adequate time is not available

The first qualification is that we must draw a distinction between those situations in which time is a pressing consideration and those in which it is not. By the former are meant those perplexities which have to be solved within a certain time if reflection is to be of any value in solving them at all. It is

obvious that the tentative attitude has its limits in such cases. It is highly important to use what time is available to consider various solutions, so that if possible the best one may be hit upon; but it is equally important to decide before time imposes a quite irrational conclusion. These situations vary all the way from those in which sudden injury is threatened, to ourselves or others, where we may not have time to wait for more than a single suggested action, to those where the decision must be reached within a term of months or years. It is obvious in all these that a position must be accepted as a practical basis for conduct which we may not at all commit ourselves to theoretically—that is, we accept a certain belief as a guide for immediate action, which we recognize might be quite inadequate if subjected to more careful investigation under conditions of leisurely study. This point, too, has been dealt with in the preceding chapter; the corollary to note here is that the habit of tentativeness must not be carried to the extreme of rendering us indecisive in the face of practical demands which will not wait our pleasure.

Suggestions which determine their own selection

The second qualification is that there are types of problems in which, in an important sense, a suggested solution inevitably leads to its own selection merely by being suggested. The general formula for these types is that they are such that any suggestion tends, when developed and acted upon, to justify itself by the event, and therefore meets no check when it occurs in later similar problems. In practice these seem to be confined to matters where the element of personal attitude or mood is a determining factor. For example, the idea that you like a certain person tends to make you act toward him in ways that increase the feeling. They are agreeable to yourself and hence add a pleasant concomitant to the feeling, and they elicit from him friendly responses which expand the feeling from the other end. Whereas, the idea that you dislike him would tend to confirm itself just as easily by the responses which are its appropriate product. In fact, the extreme difficulty of overcoming antipathies and prejudices aroused on first acquaintance has become proverbial. Again, to one caught in a perilous

situation, the suggestion that he is able to meet it victoriously is apt, by its tonic effect on the nerves and muscles, to produce its own verification, while the contrary suggestion of despair, by producing the opposite physiological effect, is likely similarly to be shown true by the outcome. The same principle functions also on a still broader scale. When we raise such questions as: Is life worth living? Is the universe good or bad? the traditional answers indicate pretty clearly that we are in a region where personal attitudes constitute the decisive consideration; where, accordingly, with different people, opposite suggestions will be apt to find confirmation. The stimulating and cheering effect of one answer tends to produce further effects which constitute evidence for the truth of the answer, while the depressing and gloomy consequence of the opposite attitude generates a situation which heightens the gloom. This is not merely, as some hastily suppose, because either attitude leads one to observe the facts which support it and blindly to pass by those that do not; it is rather that the attitude colors the facts themselves, so that to the determined optimist there is no evil that may not become a stepping-stone to good, while to the soured pessimist there is no sunshine that is not the harbinger of rain. The implications of this principle for the meaning of correct thinking in the larger questions of morals and religion are exceedingly important; they will be considered in some detail in the appropriate chapters of Part IV.

Limits of these qualifications

It should be observed, however, that even in questions of this sort the act of thought does not terminate with the third step, and this means that a suggestion is not emancipated from responsibility to its consequences and the further experiences which come upon its adoption. In other words, while any suggested solution of these problems tends to confirm itself in general, it is inevitably enlarged in meaning and modified in detail as one continues to act in the light of it.

Thus even here one cannot escape the responsibility of minute and careful attention to the fruits of a suggestion, in order to discover its fuller meaning and the specific form of its testing. Suggestions hence have to be taken with a certain penum-

bra of tentativeness when we have every reason to expect that in main outline experience will support them. But in all other questions the qualifications above noted do not apply, and it is of the highest importance that we recognize that a suggestion has no logical or rightful claim upon our action or belief till it has received adequate confirmation. This means, of course, that its bearings must be reasoned out, and the suggestion as thus expanded in meaning verified by observation or experiment if it refer to relations of empirical facts. To take a scientific attitude in one's thinking means this more than it means anything else.

The meaning of hypothesis in science

When a scientist, equipped with thorough knowledge of what has been achieved to date in his field, finds born in his mind a suggested solution of a problem to which no one has yet been able to offer a verified answer, he views it as a *hypothesis*. If it be an idea which can only be adequately tested by many years of work on the part of many people, and if some preliminary evidence is secured in its favor, it may be called a *theory*. By these terms are meant fundamentally two things: first, that the suggestion thus entertained is not to be accepted as true till it has passed the tests of verification imposed in the fourth and fifth steps of reflection; second, that it lays upon him the responsibility of doing what he can to test it, either by personal research or, if that be impossible, by handing it over to colleagues who are in a position to do so. Of course, neither he nor anyone else is bound to continue working on a suggestion to which early deductions or tests fail to give any encouragement, nor if a promising suggestion in a more important problem comes to mind. Should the hypothesis be proven by adequate deductions and tests, it takes its place in the system of science as a *law*—that is, a regular relationship in a certain sphere of nature which we are justified in believing as true and adopting as the basis of further inferences. If the law thus established be so basic in a science or group of sciences, that much or all of the other knowledge contained in them tends to organize about it as a focus and takes a form deducible from it, it may function practically as an *axiom*—that is, a

principle so well grounded that only implacable facts quite irreconcilable with it could ever compel its abandonment or radical modification. Thus the doctrine of universal gravitation, when it first occurred to Newton's mind, was a hypothesis; when confirmed by evidence drawn from the moon's orbit, a theory; when shown to be further verified by the relations between all sorts of bodies, a law; and when seen to be so central in astronomy and mechanics that other knowledge in them could be fruitfully organized about it, an axiom. Similarly, the general conception of evolution has passed through the same stages, from its first occurrence in the mind of Darwin to its acceptance by all competent investigators as the main key to the phenomena of biological history. But—and this is a third vital point to be remembered in connection with the use of hypotheses in science—no law, not even the most firmly held and seemingly dependable axiom, is ever to be regarded as absolutely final and unchangeable. Further facts may appear which, when fairly faced, demand its revision. It will always remain true in the limited sense that the facts which verified it are still what they are, and the law which replaces it must therefore include them in its explanations, while accounting also for facts which the earlier doctrine neglected. Thus the theory of evolution recognizes the differences between the various species of living things as much as the doctrine of special creation, while it accounts in the most illuminating way, as the latter does not, for the remarkable continuity between them which investigation increasingly reveals. Hence even the most firmly established law at any given time may prove to be but a limited approximation to the truth as later discovered; not only may new facts come to light, but quite different problems may press for solution which require a quite different type of hypothesis to answer them. We shall see in Part IV that this is the case in the conflict between evolution and special creation—the latter, while a valid idea from a certain point of view, is not an answer to any scientific problem, strictly speaking, at all.

If this be the essential nature of hypothesis, it is clear that the fundamental conditions of a good hypothesis are two: first,

that it should be such as to give rise to definite deductions; and second, that its consequences thus deducible be verifiable by observation or experiment. A hypothesis that does not possess these characteristics is a hypothesis in name only, it cannot possibly function as such in any genuine piece of scientific thinking. Yet many people seriously entertain suggested solutions of problems concerning empirical fact which violate one or both of these two requirements. The first is violated by appealing to the creative purpose of God to explain the differences between the various species of organic creatures. Since the divine purposes are largely inscrutable for human minds, nothing can be deduced from such a hypothesis; we cannot say that if God has created something, then such and such definite facts can be found in it. It is essentially for this reason that modern science, while not necessarily denying a religious meaning to the world, has found it necessary to abandon appeals to God as explaining this or that particular type of occurrence. The second is violated by such suggestions as that made in answer to Galileo's discovery that the surface of the moon is irregular, namely that these irregularities were filled with a transparent glassy material. Since this material is by hypothesis invisible, its presence cannot be verified by observation.

**Essential conditions of a good hypothesis**

Moreover, in general, a hypothesis that leads to the more numerous and definite deductions, some of which point to novel and unique verifying observations, is on these accounts more fruitful for scientific progress than one which possesses these characteristics in smaller degree. According as the deductions are more numerous and the experiments novel, the more likely is the hypothesis to lead to an unexpected and suggestive outcome in the form of new problems and possible answers to them; while if a consequence is so unique and peculiar that it could not be connected with any other hypothesis, our verifying observation will be able to establish a given explanation definitely as against all other possible hypotheses. This is important because there are often groups of facts that can apparently be accounted for by any one of several hypotheses, so long as no one of them can be seen to involve some unique verifiable consequence.

**Importance of hypotheses whose consequences are unique**

Where such unique consequences are impossible in the nature of the case, as in certain astronomical and geological problems, the principle of parsimony decides; its nature and function will be considered more at length in chapter thirteen. In short, science is not satisfied with a hypothesis that can merely be verified by the facts; it demands, if possible, such a hypothesis as can be verified to the exclusion of all others. And even hypotheses that ultimately prove to be false may be highly valuable in furnishing helpful leads to other problems or pointing to the discovery of novel facts. Malthus' theory of population, for example, has in general lacked verification in the field to which he applied it, but in Darwin's hands it became the key to a verifiable account of the origin of species.

Beliefs not scientifically established should be held with still greater tentativeness

But the corollary of this discussion here is mainly a lesson already touched upon in Part I, so important, however, that repetition and enlargement can do no harm. If even the surest results established by the most careful and painstaking methods of science are provisional rather than absolute, it is obvious that beliefs which rest upon no such solid basis are much more likely to be inadequate if not downright false. Accordingly, the priceless habit of tentativeness in belief, and eagerness for new truth, for which the notion of hypothesis in science so definitely stands, is in the case of such ideas much more vitally needed. And of course, when this is recognized, it leads to and enforces another habit, that of seeking and using the results of scientific method that are available in any field of human interest in preference to notions otherwise founded, except so far as we are in a position to expand and correct those scientific results themselves. Few of us, however, can be scientific pioneers in anything but the most meager sense; the most important reflective lesson that we can learn is therefore to accustom ourselves to turn in any problem we face to the knowledge scientific method has to offer for its illumination, to make sure that we are emancipated from superstitions that have been exploded by accurate scientific tests, and to fortify ourselves by as varied and specialized a wealth of scientific information as possible on the types of situa-

tion in which our work will most constantly involve us. In an age when Newtonian physics, which has reigned in the world of science for more than two hundred years, has been shown inadequate to the facts which present-day observation and experiment reveal, this is the supreme lesson to draw. Its importance will become clearer still when by an analysis of the conditions of good thinking at steps four and five we have a better conception of what scientific method really involves, but a consideration of step three in its bearing on the fundamental idea of hypothesis would hardly be complete without an indication of its significance for such a lesson.

**How can we further the formation of appropriate suggestions?**

The third question which appropriately occupies us in the present chapter is: In the case of complex problems, where the securing of a promising suggestion seems particularly difficult, what can be done to help along the mysterious work of constructive imagination in forming the appropriate suggestion? Granted that the conditions so far laid down in the chapter have been met, granted time enough to deal with the problem without the pressure of immediate need, and granted that the difficulty is such that no stereotyped set of alternatives limits choice of answer, how can we hasten the formation of an appropriate hypothesis? This is a very difficult question, yet not without much human experience to furnish the outline, at least, of an answer. The scientist struggling toward the grasp of a novel generalization that shall adequately unify a group of puzzling facts as well as the experiences which gave rise to a law he has now abandoned; the creative artist striving to envision a form which shall express in terms of the medium before him a purpose heretofore statable only in vague and general concepts; the philosopher seeking a system of conceptions by which the entire baffling panorama of his experience may be adequately and at one fell swoop interpreted—these illustrate in the grand manner the situation now in question. But on a less important scale every thinker needs what help can be given at the same point, for we all have periods during which we are incubating problems that refuse on first clarification to yield a promising hypothesis.

Testimony of successful thinkers on this point

The amount of scientific knowledge that can at present be offered on this important matter is almost *nil,* but in his recent book on *The Art of Thought,* Graham Wallas has well summarized the few valuable hints that now seem justified. In the case of problems subsidiary to more fundamental ones, or of secondary importance, Wallas finds it desirable to clarify further difficulties while waiting for promising suggestions on the one in hand. This naturally economizes time and does not seriously hamper the process of subconscious incubation. Our educational system presupposes this method in requiring teachers and students to occupy themselves with two or more different courses during the same semester, turning successively to each. On the larger and more general perplexities, however, a period of complete intellectual relaxation is desirable. This may include physical relaxation also, or it may involve a moderate degree of physical exercise, not carried to the point where conscious effort is needed to control the muscles exercised. Such a situation seems to favor the complex sifting process in which the data gathered during the period of intensive study or clarification (which Wallas calls preparation) separate and combine in manifold ways under the guidance of our controlling purpose, till an idea emerges which seems to unify them all in the precise way required by the difficulty. Such relaxation overcomes fatigue and removes the inhibitions which effort in false directions has set up—what other values it has for the furthering of significant intuitions are more obscure. But from a study of the intellectual biography of a number of eminent thinkers Wallas finds that the practice of relaxation has played an important part in their great achievements. Thus he quotes Helmholtz, the great German physicist, as saying that after previous investigation of the problem "in all directions . . . happy ideas come unexpectedly, without effort, like an inspiration. So far as I am concerned, they have never come to me when my mind was fatigued, or when I was at my working table. . . . They came particularly readily during the slow ascent of wooded hills on a sunny day." Similarly, Poincaré, the French mathematician, made two of his greatest discoveries after periods of

incubation, due in the one case to military service as a reservist and in the other to a lengthy journey. During these periods no conscious mathematical thinking was done. Oftentimes, indeed, great hypotheses emerge under conditions which one would not *a priori* suppose to be very favorable, as for example when a period of relaxation is enforced by sudden or chronic illness. "A. R. Wallace, for instance, hit upon the theory of evolution by natural selection in his berth during an attack of malarial fever at sea; and Darwin was compelled by ill-health to spend the greater part of his waking hours in physical and mental relaxation." The same general testimony comes from the realm of art, though it does not appear so necessary that the time of incubation for the creator in music, poetry, or sculpture should be spent in complete abstraction from manipulation of his materials. In religion, relaxation in an attitude of worship has long been recognized as a helpful prelude to the securing of prophetic visions. With philosophers, on the other hand, single intuitions, even under the most favorable circumstances, seem rarely adequate to the exceedingly complex problems which they dare to attack; the subsequent process of development, verification, and systematization modifies them so greatly that in retrospect the mere occurrence of the hypothesis tends to lose unique significance.

**Habits favorable to the occurrence of suggestions**

What habits of intellectual work is it desirable to form, in order to further the occurrence of fruitful suggestions, beyond provision for relaxation and incubation as above described? Wallas tries to answer this question, too, but the scientific knowledge here available is again almost nonexistent, and the guiding suggestions that can be given seem almost commonplace. Of those made by Wallas that are confirmed by the author's experience and that of those whom he has consulted, three may be mentioned. First, one should have definite habits in his intellectual work—that is, he should set apart a regular time each day or week for creative thought. This is not merely to avoid waste of time, but because creative imagination, though a mysterious affair, can be led to subject itself to temporal routine to some extent. After persisting in the habit for some time,

one will find his creative energy gaining its maximum of effectiveness at the time he has set apart in a fairly dependable way. Second, the surroundings under which one works should be as free from external distractions as possible (especially sudden irruptions upon attention) and should be æsthetically pleasing. This insures, on the one hand, opportunity for continuous concentration on a train of thought, and on the other a gentle and tonic stimulus to imaginative activity. Third, it is very important to have a few blank cards constantly on one's person or by one's side, and to jot down at once a suggestive idea suddenly appearing, before it is lost. Many people find the moments of relaxation in bed just before dropping off to sleep especially favorable to the occurrence of valuable suggestions—if cards and a pencil are not handy, the illuminating thought may be impossible to recover in the morning. Such habits are very difficult to establish and practice persistently, but anyone who wishes to make serious contributions cannot afford to neglect them. Wallas refers, in passing, to the pathetic case of a man who suddenly conceived a brilliant idea—the solution, it seemed, of the problems of a lifetime. Instead of recording it at once he went into his garden to thank God for it, whereupon he found, on rising from his knees, that he had forgotten it and could never afterward recall it. Such cards should be filed in a considerable number of folders labeled with the names of subjects to which one's mind recurs, including one large folder marked "Redistribute," into which all suggestions are put that are felt to be significant, but which do not seem to belong to any of the sections already labeled. This folder should be frequently and carefully ransacked, for it is in just such a collection that new ideas are most likely to be found.

Matters on which individuals vary

There are, of course, many practices on which individual variation is so great that no general rule can insist upon them. Such, for example, is the effect of pressure on creative work, the requirement that some result be attained by a certain time. Many people seem to require such pressure to accomplish their best work; they consciously form the habit of doing first each day what could be put off, leaving till later what could not, so

that the latter, at least, will always be done under the stimulus of great pressure. Others, again, become nervous when thus driven; their imagination works most fruitfully in an atmosphere of leisure.

More exact knowledge of the laws governing the occurrence of relevant suggestions will be seen by the above sketchy treatment to be one of the greatest desiderata in the effort to improve our reflection.

EXERCISE A.—On the basis of a reflective survey of your past experience, formulate a hypothesis of conditions favoring the occurrence of suggestions that is more detailed than the rules outlined in the present chapter. Test your hypothesis systematically and make a report of the result. Do you think your result would hold good in the case of others? Why?

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## CHAPTER SEVEN

# THE CONDITIONS OF CORRECT REASONING

### *Section 1.* INTRODUCTORY

**Task of the chapter**

THE fourth step in an act of thought consists, as we saw in chapter four, in a process which is as peculiarly inner and mental as the occurrence of suggestions, but which differs from it as reasoning or inference from an idea differs from the mere presentation of the idea. The more common synonyms by which this process has been described—reasoning out the consequences, deducing the implications, elaborating the bearings, etc., of a suggestion—are now familiar to us, and we noted that such a train of thought can always be expressed verbally in a complex sentence whose subordinate clause begins with the word "if" and whose main clause with the particle "then." The suggestion whose implications we are deducing is stated in the "if" clause, and the implications (or consequences, or bearings) are stated in the main clause. Our task in the present chapter is to analyze the conditions of the correct performance of this process.

**Difference between deduction as thought and as formulated for logical testing**

We should observe first that the form in which we spontaneously express this act of reasoning is not usually the form in which it needs to be expressed if its correctness or incorrectness is to be clearly revealed. The natural form is likely to be elliptical and to lack precision. For example, suppose my problem is how best to reach a certain appointment downtown. The suggestion occurs, take the bus. At once I proceed to reason (since the time consumed on the trip is an important factor): If I take the bus, the trip will be apt to consume about forty minutes. Now it is clear that in order to test this reasoning accurately the statement needs to be expanded so as to show the exact ground or basis on which this conclusion is thus confidently inferred from

this condition. As thus expanded and made precise, the reasoning will assume something like this form:

> Trips downtown on the bus are apt to take forty minutes.
> This projected trip is a trip downtown on the bus.
> Therefore this projected trip will be apt to take forty minutes.

Sometimes, of course, our reasoning naturally takes substantially the form required to test it accurately. Suppose I need to determine the general direction of Amarillo from Memphis. I remember that Amarillo is almost due west of Oklahoma City and that the latter is almost due west of Memphis. So I reason:

> (If) Amarillo is due west of Oklahoma City
> (and) Oklahoma City is due west of Memphis
> (then or therefore) Amarillo is due west of Memphis.

But this situation is not nearly as common as the former.

Connection between the psychology and the logic of reasoning

Now the fact that our actual thinking usually takes a form quite different from that into which it must be put if it is to be tested as to the correctness of the reasoning involved, has led some to regard the two as quite incommensurable, to hold that the psychology of reasoning has no significant relation to the logic of correct reasoning. The fact that some cases of actual reasoning do conform without change to the standards of logical correctness suggests that such thinkers have greatly exaggerated the difference. Indeed, if there is no definite relation between them our entire enterprise would collapse, so far, at least, as concerns the fourth step of an act of thought.

Our excursion into the evolution of thinking (in chapter two) has given us the key to the solution of this difficulty. Primitive reasonings are, to be sure, apt to be quite illogical. Conclusions are connected with conditions, not because they really follow from them, but simply because they have acquired a vivid association with them through the influence of emotional interest, social tradition, or the like. But as people get into trouble through acting on such reasonings they are induced gradually to modify their reasoning processes when facing similar problems in the light of the unfortunate lessons thus enforced. They learn to be on their guard against the illegitimate influence of such factors, to guard against them in the way in which they pass

from condition to conclusion. Suppose, for example, a business man has postponed embarking on a certain enterprise because it would have begun on Friday, unconscious that this assumes that "all enterprises begun on Friday are likely to be unsuccessful." Through the delay thus caused his enterprise meets failure. He may thus be led to consider whether the inference he had made were really well grounded, or whether the association between Friday and failure were due simply to emotional attachment or uncriticized tradition. He may then be willing on a future occasion to try an inference whose assumption could be better justified in terms of empirical fact. The first step will be made toward forming the habit of guarding his reasoning against the play of illogical influences.

This does not mean, of course, that in people's actual thinking they may ever come to state all their deductions in the complete and exact form required to reveal their validity. It does mean that they acquire a vague sense of what that form would be, and more and more develop the habit of respecting it in subconscious fashion when they follow out any suggestion to its consequences. Thus it is natural for a primitive mind to reason that a particularly striking or interesting consequence that has been observed to follow a given event must follow it again when it recurs, as victory in war after a certain configuration of the omens, but experience gradually teaches that it is regularity of connection between condition and consequence that validates the reasoning rather than an occasional connection of unusual vividness. Gradually the habit is formed, as experience develops, of implicitly recognizing the authority of this principle and of reasoning in ways whose underlying ground, if stated, would be in accordance with its demands. Then, as nations appear with certain classes given freedom from absorbing economic pursuits, who are able to devote themselves to inquiries of no immediate and pressing practical concern, and as the importance of the mental development just sketched draws the conscious attention of certain members of such classes, the problem sooner or later becomes clearly faced of the explicit formulation of the conditions of correct reasoning which have become gradually recognized

implicitly. Thus deductive logic arises as a formulated science of correct reasoning. In the ancient world this development took place among both the Greeks and the Hindus, though in an inadequate form due to their general assumptions about the nature of thinking and the inadequacy of generally current beliefs about the world. Among the Greeks, Aristotle was the great formulator of the principles of correct reasoning, and his scholastic followers in the Middle Ages worked them out with subtle and minute attention to all the detailed relations involved. The history of deductive logic in the modern world has been marked by the correction of certain mistakes in Aristotle's assumptions about thinking and the inclusion of his main results as an integral part of a far more extensive system of deductive thinking.

The articulation of a piece of correct

Now let us return to the difference noted at the beginning of this chapter between the usual form of the deductive process as occurring in our actual thinking and the form in which we were forced to put it when we wished to test its correctness—that is, to the first of our two illustrations. What is the most noticeable difference between those two forms? Obviously, that the second contains a general statement not contained in the first—in this case the statement: trips downtown on the bus are apt to take forty minutes. In what ways, now, does the correctness of the conclusion we draw from the suggested condition (if I make this trip on the bus) depend on that general statement? Obviously, in two ways. In the first place the deduction is not correct unless that implicitly involved general statement is justified by the facts it attempts to summarize. If it is not empirically verifiable that trips downtown on the bus are apt to take forty minutes, then I cannot legitimately conclude that if I take such a trip now it will be likely to consume so much time. In the second place the deduction is not correct unless, taking the truth of this general statement for granted together with that expressed in the suggested condition (this projected trip is a trip on the bus), the asserted conclusion *necessarily* follows. *That is, the general statement must so articulate the entire piece of reasoning that if it and the suggested condition be admitted*

*or asserted together, the conclusion must also be admitted.* Its meaning, in other words, is seen to be so bound up with their meaning that you cannot grant them without granting it also. The importance of this may be seen if we consider a bit of reasoning which is otherwise sound but which does not meet this condition, and one which somebody might unwarily assume to be correct.

> Great men have been ridiculed.
> I am ridiculed.
> Hence I must be a great man.

Here a careful examination of the meaning of the first statement discloses that it does not at all say that everybody who is ridiculed is a great man, but only that some great men have been ridiculed. But the former alone could yield, in conjunction with the second statement, the asserted conclusion. It does not necessarily follow from the latter.

Further limitation of the problem of deductive logic

Now while a study of the first of these requirements about the general statement involved in any deduction might properly be taken up in this chapter, it will be better to postpone it. For we must remember that when we are at the fourth step of any actual act of thought we have to take for granted (explicitly or implicitly) the best available general principle that our past experience seems to justify. When my problem is that of getting downtown at a given time, I ordinarily have no leisure to determine whether the best formulation I can make in terms of past experience of the time it takes to make the trip on the bus is correct for the purposes of that problem; I make the best estimate that I can, and on the basis of its acceptance decide whether the bus is the best means to my chosen end. Furthermore, if I did raise the question of the correctness of that formulation and seriously set about answering it, I should have dropped my original problem for a quite different one; it would no longer be, How shall I get to that appointment? but, How long does it really take to go downtown on the bus? And I should find, when I came to the fourth step of this new problem, that I should there, too, have to take for granted general principles derived from past experience, without, at least at the time,

raising any question about their correctness. So it will be decidedly best to leave to the next part of the book the inquiry into how we establish true general statements of this sort, and restrict the study of the present chapter to the conditions of correct reasoning revealed in the other requirement—that is, *that the general assertion implied by our reasoning be such that when we grant both it and the suggested condition, we must necessarily grant the conclusion also.*

Difference between validity and truth

The task of the present chapter thus coincides with that of the branch of logic which since the very beginning of the formal study of the science has been termed *deductive*. Under what conditions, given certain assertions, do other assertions necessarily follow from them (can be deduced from them), as their consequences or implications? Such is our problem. And we should become familiar at this point with a technical term. This is a study of the *validity* of reasoning. A piece of reasoning whose conclusion does really follow from the assertions which purport to imply it, is *valid*. One whose conclusion does not follow is *invalid*. Notice that *validity* is not the same as *truth*. An assertion may be untrue, and yet, if its meaning is clear, it is possible to tell whether another assertion necessarily follows from it or not. For example:

> All negroes live in the Southern states.
> 'Rastus Johnson is a negro.
> Therefore, 'Rastus lives in a Southern state.

Here the first statement is palpably false, yet the reasoning is valid—that is, the conclusion follows from the statements which purport to yield it. Observe also that without further information we do not know whether the conclusion here is true or false. It might happen to be true, in spite of the falsity of the first premise. On the other hand, of course, it might be false in spite of the validity of the reasoning. Hence there is no necessary relation between the validity of any reasoning and the truth of its conclusion, or of the other assertions which function in it. But, and this is the fundamental point for our present analysis, *if those assertions are true and the reasoning is valid, the conclusion must be true.* We see, then, the vital importance

of a systematic study of the conditions of validity. Unless the reasoning is valid, correct premises cannot guarantee correct conclusions. And until we have confirmed the conclusions in other ways the only assurance we can have of their soundness is founded on the assumed truth of the premises plus the validity of the reasoning. Since such further confirmation always involves effort and often risk, it is highly desirable that we understand clearly the conditions of valid reasoning and form the habit of rigorous adherence to them in our own thinking on whatever subject. Knowledge will aid practice here as elsewhere. If, therefore, we wish to avoid error in our deductions, it is essential to understand the conditions of valid deduction.

## *Section 2.* THE SYLLOGISM

Illustrations of valid reasoning

Consider the following pieces of valid reasoning:

Cæsar conquered Gaul.
Cæsar was charmed by Cleopatra.
Therefore, a conqueror of Gaul was charmed by Cleopatra.

Chicago will build a subway.
The cost per mile of a subway is very high.
Therefore, Chicago will build a means of transportation whose cost per mile is very high.

This key is in tune with the G string.
The G string is in tune with that bell.
Therefore, this key is in tune with that bell.

Most business men are progressive.
Most business men are Republicans.
Therefore, some progressive people are Republicans.

Henry is the father of James.
James is the father of Sally.
Therefore, Henry is grandfather of Sally.

Omaha is west of Chicago.
Topeka is south of Omaha.
Therefore, Topeka is southwest of Chicago.

William is of the same age as Mary.
Mary is younger than Cynthia.
Therefore, William is younger than Cynthia.

The amount of this stock is today increased by a fifty per cent dividend.
The value of the old stock is $123 per share.
Therefore, the value of the new stock is $82 per share.

All red-haired boys are mischievous.
John J. is a red-haired boy.
Therefore, he is mischievous.

No airship is safe.
Some of these structures are airships.
Therefore, some of these structures are not safe.

If a car goes faster than thirty miles an hour on this road, accidents are likely.
That car is going faster than thirty miles an hour.
Therefore, an accident is likely.

The trend of the stock market is either up or down.
Its recent action indicates that the trend is not up.
Therefore, it is down.

Horace is a son of Ruth.
Eleanor is a sister of Ruth.
Georgia is a daughter of Eleanor.
Therefore, Horace is first cousin to Georgia.

Eli Whitney was the inventor of the cotton-gin.
Therefore, the cotton-gin was the invention of Eli Whitney.

Mr. X is richer than Mr. Y.
Therefore, Mr. X is not poorer than Mr. Y, nor equal to him in wealth.

The above list could be greatly expanded if we wished to secure an exhaustive analysis of all the types of deductive reasoning that could be distinguished clearly from one another. But these illustrations will be sufficient to teach all the lessons that we need to learn.

Conclusion and premises in a piece of reasoning

Let the student examine these inferences carefully. In the first place, note that with the exception of the last three all of these arguments consist of three sentences. When arranged in their most natural order the last of these is the *conclusion* which necessarily follows from the other two, and it is usually introduced by the terms *therefore, hence,* or some synonym of these. The two statements which imply or yield the conclusion are known technically as the *premises*. That is, they express that which, for the purposes of the argument, is taken to be true without question. In those types of argument in which one premise is broader in meaning than the other, such as the ninth and tenth in the above list, a distinction is usually drawn between *major* and *minor* premise, the major being the universal or broader statement, and the minor the particular or more limited one. When the argument is properly arranged the major premise should be stated first, and its predicate will usually be the same as that of the conclusion. The latter consideration enables us to order correctly an argument which may happen to be arranged differently at first.

The order of premises and conclusion

Before we proceed in this analysis it will be well to recall that in our actual thinking the order is always: first, one or both premises; second, the conclusion. This is apparent when we see that if the conclusion were present in our minds at the beginning the attempt to reach it would involve no inference and nothing corresponding to the fourth step would really take place in our thinking. As already noted, in most cases the conclusion is overtly connected with only one premise, the other (usually the major) only being explicitly asserted when the validity of the reasoning is to be tested, although in any given case both premises may be explicitly formulated. Yet when an argument is presented in speech or print for the persuasion of others, its statements may be in any order. The student needs, therefore, to gain facility in distinguishing quickly the conclusion from the premise (or premises). This may usually be done by remembering that the conclusion will naturally be introduced by *therefore, hence, then,* or some synonym, while a premise will often be introduced by *because, for, since,* or some term of similar mean-

ing. It states the reason or ground on which the conclusion rests. If no such conjunctions are used, the purport of the argument must be studied in its context, and premise and conclusion thus determined.

EXERCISE.—Distinguish premise and conclusion in the following:

1. This road cannot be the main road, because it is evidently little traveled.
2. He must be Protestant, since he exercises the right of private judgment in religion.
3. I love little pussy, her coat is so warm.
4. Anyone who says "Coward" is a liar. I heard you say "Coward."
5. Mary is evidently taller than John, because John is a little shorter than Richard.

Enthymemes

Notice that in the third of these examples a question might be raised as to whether the ideas there brought together constitute a genuine deductive argument at all—that is, whether what in form appears to be a conclusion is really intended to follow from the other assertion as a premise. What would the remaining premise have to be to make a valid argument out of this thinking? Would anybody be apt seriously to intend such a premise? The problem this suggests will be discussed later. The student will find it helpful at this point to gain a little preliminary practice in supplying the missing premises in these deductions and stating them in precise form. The technical description of an argument thus left incomplete is *enthymeme*. Observe that in the fourth example the conclusion is not explicitly stated. That is a logical trick sometimes resorted to for the sake of emphasis. The entire process of thought may be formulated in something like this fashion:

Anyone who says "Coward!" is a liar.
You are one who says "Coward!"
Therefore, you are a liar.

What is the unit of deductive thinking?

Let us return now to the last three examples in our list, which seem to be exceptions to the general rule that a unit of deductive reasoning consists, when stated in precise form, of two premises and a conclusion. The first of these three will give us no trouble when we see that, although in the form

presented it consists of three premises and a conclusion, it can be reduced to two deductions, each conforming entirely to our general rule. The reasoning is clearly equivalent to:

Horace is Ruth's son.
Eleanor is Ruth's sister.
Therefore, Eleanor is Horace's aunt.

Eleanor is Horace's aunt.
Georgia is Eleanor's daughter.
Therefore, Horace is first cousin to Georgia.

When put in this form the reasoning reveals the same deductive unit as we have found present in the other cases. The only difference is that we have here a slightly more complex piece of reasoning, of which we can see the validity without the repetition necessary to put it in units of three statements each. The same situation is revealed in any demonstration in a mathematical science, such as algebra and geometry. But in all these cases we can, if we wish, reduce the argument to units consisting in each case of two premises and a conclusion.[1] This

[1] It may be worth while to illustrate this point from familiar types of mathematical reasoning:

In algebra:

$(a + b)(a - b) = 8.$
$a^2 - b^2 = 8.$
may be expressed as:
$(a + b)(a - b)$ is equal to 8.
$(a + b)(a - b)$ is equal to $a^2 - b^2$.
Therefore, $a^2 - b^2$ is equal to 8.

In arithmetic:

$$\begin{array}{r} 6 \\ 12 \\ 7 \\ \underline{9} \\ 34 \end{array}$$

may be expressed as:
6 + 12 is equal to 18.
18 + 7 is equal to 25.
Therefore, 6 + 12 + 7 is equal to 25.

strengthens our presumption that such a unit constitutes the typical and fundamental form of deductive thinking, whose analysis in detail will give us the answer we need to our problem of the conditions of correct reasoning. But we need first to examine the other two examples.

**Immediate inference distinguished from enthymeme**

Here, apparently, we have a type of inference in which only one premise is needed to yield the asserted conclusion. Some logicians have, in fact, denied that there is here, properly speaking, any inference at all, that is, they have held that the conclusion expresses exactly the same idea as the premise, merely putting it in another form. To say that Eli Whitney was the inventor of the cotton-gin is to convey exactly the same meaning, no more and no less, as to say that the cotton-gin was the invention of Eli Whitney. That the type of reasoning is different from that which can only properly be articulated in three statements, we may readily agree, and it is a verbal matter whether we wish to call it a form of inference or not. Most logicians have analyzed its possibilities under the head of "Immediate Inference," and it is by that caption that we shall introduce a more detailed discussion of it below. But at present we need simply to distinguish it clearly from the other type. As a help to this, the student should gain a little practice in separating cases of immediate inference from enthymemes. As we saw, an enthymeme is an argument which, when precisely formulated with no missing link, requires two premises and a conclusion, but which, as stated, is incomplete. A case of immediate inference on the other hand is complete with no second premise.

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6 + 12 + 7 is equal to 25.
25 + 9 is equal to 34.
Therefore, 6 + 12 + 7 + 9 is equal to 34.

In geometry:

Δ ALD = ½ Sq. AE.
Therefore, Δ ALD = Δ BEC.
may be expressed as:
Triangle ALD equals one-half of square AE.
Triangle BEC equals one-half of square AE.
Therefore, triangle ALD is equal to triangle BEC.

EXERCISE.—Distinguish enthymeme from immediate inference in the following pieces of reasoning:

1. Ralph must be younger than Tom, because George is Tom's twin brother.
2. Ralph must be younger than Tom, because he is not older nor of the same age.
3. Line AB is equal to line CD because CD is neither longer nor shorter than it.
4. You cannot enter here because there is no admittance except on business.
5. All who are not on business are excluded because there is no admittance except on business.
6. No prophet is bound by the standards of the past, hence none who are bound by the standards of the past are prophets.
7. All evil is painful. Therefore, nothing that is not painful is evil.
8. If you elect this candidate, then continued prosperity is assured.
9. God's in his heaven; all's right with the world.

Two premises and their conclusion the essential unit of deduction

Consideration of these examples will clarify the distinction between these two types of deduction. That which we have called immediate inference does not involve passing beyond the meaning already included in the given premise. It expresses that meaning in different forms, by various modes of manipulation, and later in the chapter we shall examine these modes in detail. And this process is a genuine enlargement of thought in so far as the new forms brought out in the conclusion reveal aspects of the idea which were not explicitly present to attention in the original form. But inasmuch as no other idea is introduced, the range of enlargement possible in this way is strictly limited, and few problems in our actual thinking can be adequately dealt with merely by immediate inference from some suggestion. A problem that could be thus simply solved would not be apt, in most cases, to rise to clear consciousness at all. In practically all cases of real thinking deductive inference is of the other type, and immediate inference, if used at all, plays a subsidiary rôle in this more complex process of reasoning. Here two different meanings are combined to yield a third, which could not be asserted on the ground of either one of them alone, but is very definitely their joint product. Hence the range of possible conclusions is vastly extended. It is not

limitless, for two statements taken at random may not yield any valid deduction at all, as, for instance:

> **George Washington was the father of his country.**
> **The temperature was below zero yesterday.**
> **Therefore (?).**

That is, for deductive inference to be possible, the meanings of the premises must be related in a definite way, which we shall soon study. But when we bring two meanings together that are thus related we find them marvelously fecund, enabling us, as we saw in chapter two, to focus the wealth of our past experience, in both generalized and specialized form, on the problem in hand, and thus realize the consequences of our suggestions without the delay and danger of committing ourselves to each of them in overt action. Because, then, of the fact that actual thinking at the fourth step is almost always, if not quite universally, of this type, and because it is more complex, including the other as a frequent subsidiary process, we shall take this form of deduction as central for our analysis. In two premises and their jointly implied conclusion we have the fundamental unit of actual reasoning when it is stated in exact form for the purpose of testing its validity.

This unit termed the syllogism

This unit of deductive inference we shall call a *syllogism*, broadening somewhat in so doing a technical logical term which has hitherto been used in a more restricted sense, as applying to what we shall distinguish as one of its types merely. A syllogism, then, as the typical unit of deductive thinking, consists of any group of three assertions, of which one purports to follow when the other two are granted. And with this result we may restate our inquiry in the present chapter in the form, What are the necessary conditions of a valid syllogism?

## *Section 3.* PROPOSITIONS, TERMS, AND RELATIONS

The proposition

We have become familiar with one fundamental fact about the syllogism. When expressed in full and precise form, it consists of three statements, of which two furnish the ground on which the third is asserted; that is, two are premises, the third

is their conclusion. Let us examine the structure of the syllogism in further detail.

The definition of what we mean by a proposition will not detain us long. Each of the three statements which function in a syllogism is a proposition. Put in another way, a *proposition* is any grammatically complete sentence which serves, or is thought of as possibly serving, in the capacity of premise or conclusion of a syllogism. A syllogism always consists, then, of three propositions.

Terms

Now let us examine the structure of a proposition. The fact that it is thought of as functioning in a syllogism makes our analysis fundamentally different from that of a grammarian, whose task is to study sentences simply as sentences, whether they are logical propositions or not. If we look at our lengthy list of illustrative syllogisms in the light of this thought, the first important point discovered is that there is a part of each of the premises that is common to them both, and that there is also a common part between each of the premises and the conclusion. All of the illustrations reveal this in essentially the same way. Let us pick out for special examination one that will bring out the point most easily.

> Henry is the father of James.
> James is the father of Sally.
> Therefore, Henry is the grandfather of Sally.

Here "James" is common to the two premises; "Henry" is common to the first premise and the conclusion. Furthermore, it is clear that unless there are common elements in these precise ways, no valid inference is possible. For example, if the second premise read: "William is the father of Sally," obviously no conclusion could be deduced from the premises; in fact, they would not be genuine premises at all. It is evident also that the conclusion, to be a valid deduction from the premises, must assert something about other parts of the premises than their common part. From these premises we cannot deduce anything about James, still less about anybody or thing not mentioned in the premises at all. This, indeed, hardly needs illustration; if the student wishes, he may test other conclusions, such

as: "Therefore, Henry is the uncle of Priscilla." Furthermore, observe that these common elements refer to individuals, who may be considered in various possible connections with one another. In this particular case each of these individuals is a single human being, but if we compare with the other illustrations we shall find cases of common elements referring to various kinds of objects, and referring to them in the plural as well as the singular. Instances are: "business men," "airships." Now any part of a proposition which may function as the common element between premises or between a premise and conclusion, and which refers to an object or group of objects that may be thus considered in various connections, is called a *term.* Accordingly, in the above syllogism, "Henry," "James," and "Sally" are the three terms. And it is well to note from the very beginning that when the two premises contain only two terms each, the entire syllogism can contain only three—that is, if it is to be valid.

Relations

What, now, is there in a proposition besides the terms? What is meant with reference to its function in reasoning, by such a phrase as: "is the father of . . . "? Dropping the little word "is" for a moment, it is evident that the rest of the phrase performs the function of placing one term in a certain *relation* to another. To say that Henry is the father of James is to say that Henry stands in a certain relation to James, likewise to say that Henry is grandfather of Sally is to affirm a certain relation between them. Consider the propositions in the other syllogisms, and pick out the terms and relations contained in them. "Cæsar conquered Gaul" is equivalent to: "Cæsar stood in the relation *conqueror of* to Gaul;" "Cæsar was charmed by Cleopatra" is the same as to affirm that Cæsar stood in the relation *charmed by* to Cleopatra. With a little practice the student will find himself able to identify the terms and their relation in any given proposition. To say that Chicago will build a subway is to say that Chicago will enter the relation *builder of* to a subway, and similarly in the other propositions that have so far occurred through the chapter.

Difficulty of defining relations

Four points must now occupy us before we terminate the present section.

In the first place, it is not so easy to offer a helpful definition of *relation* as it is to define the word *term*. It will be found, on attempt, that the definition will be forced to use some synonym of the word to be defined. The reason for this is that to define anything is to reveal certain relations in which it stands to other things, and hence an understanding of what relation means is presupposed in every definition. A definition of relation must, hence, be circular in the nature of the case, and if the student finds difficulty in making the notion perfectly clear, the end can only be gained by constant practice in identifying relations of various types. But the fact of relationship is so deeply involved in all experience that few will find serious difficulty in distinguishing terms from relations.

The two logical functions of "is"

In the second place, let us turn our attention to the little word "is," whose examination we postponed a moment ago. In many propositions it is evident that this word plays the function of assertion merely; it *asserts* that the subject term stands (stood or will stand in the case of its other tenses) in the relation described to the predicate term. Thus in the proposition: "Henry is the father of James," the word "is" simply *asserts* that the relation "father of" holds between Henry and James. And in most of the other propositions which we have examined the same is true, or else the proposition can be reworded so as to take the same form. For example: "Cæsar conquered Gaul" can be expressed in the form "Cæsar was conqueror of Gaul."

But there are many propositions in which this innocent little word plays a more complex rôle. Take the proposition: "Most business men are progressive." Here the word "are" not only plays the function of assertion that has just been noted, but implicitly contains the relation asserted as well. And this relation is of a quite specific type. How to construe it properly has long been a problem of logicians, and no solution is yet agreed upon. But it is essential to realize that in these cases the burden of both assertion and a specific relation is borne by some

form of the verb "to be." And, fortunately, although there are unsettled disputes about the proper interpretation of the relationship asserted, there is one mode of interpretation which will always enable us to avoid error in syllogisms containing such propositions. This is to consider the relation one of *inclusion.* That is, to say that most business men are progressive is to say that most business men are *included* in the class of individuals to whom the term "progressive" applies. Similarly, to affirm that no airship is safe is to deny the relation of inclusion and to assert that of *exclusion* between airships and safe things; the class of objects described by the term "airship" and the class described by the term "safe" have no objects in common. In general, the student will find that where no other relation is verbally affirmed in any proposition, the relation in which it is to be construed is that of inclusion or its opposite. The special problems of inference involving such relations will occupy us below. They are important because the relation is a very common one in our reasoning.

Determination of terms and relations depends on how they are used

In the third place, it is well to note that while many propositions are so simple that their analysis into terms and relations can be confidently performed without knowing how they are to be used in a syllogism, this is not always the case. The meaning of a proposition is its meaning in the syllogism in which it is to be used, and in complex propositions this may not be apparent, so far as determining the terms and relations is concerned, unless the rest of the argument is known. For example, if we were given the proposition: "The cost per mile of a subway is very high," and knew nothing else about the reasoning in which it was to be used, it would be quite impossible to say with assurance what the precise terms and relation are. But the other premise (or the conclusion) gives us our common term and enables us to construe the proposition. "Chicago will build a subway." Hence "subway" is the common term. The proposition can then be formulated in this fashion: "A subway is a means of transportation whose cost per mile is very high." Here "subway" is one term; "means of transportation . . . very high" is the other, and the relation is one of inclusion.

Another illustration thus appears of the fact that the real unit of deduction is the syllogism, and that the meaning of its various elements is to be determined by their function in the syllogism. That we face no such problem in the case of propositions like "Omaha is west of Chicago," or "James is father of Sally," is simply due to the fact that in statements of this sort there is no possible ambiguity about either the terms or the relation.

A given word may be part of a relation or part of a term

In certain cases, moreover, it is impossible to tell clearly, without the remainder of the argument, whether a certain word in a proposition is a part of the relation or a part of one of the terms. Suppose, for example, we were given the proposition: "Mr. A. is an inhabitant of Australia." At first sight we should naturally assume that "Mr. A." and "Australia" were the terms, and "inhabitant of" the relation. This would be correct if "Australia" were one of the terms in the other premise, making it the common element between them, as in "Australia is the smallest continent." Then we could deduce the conclusion, "Mr. A. is an inhabitant of the smallest continent." But suppose the other premise were the following: "All the people of Australia are enterprising." This shows that the common element of the two premises is not "Australia," but "people" or "inhabitants of Australia." Accordingly, "inhabitant of" becomes a part of one of the terms instead of the relation, and the relation must be construed as that of inclusion. It is meant that Mr. A. is included within the class of inhabitants of Australia.

The student will find practice desirable in discerning terms and relations in situations of this kind. When a single proposition is given to be dissected, it is usually best to assume that as large a part of the proposition as possible is to be assigned to the relation. This practice has the additional advantage of affording familiarity with a larger number of relations than we should otherwise be apt to consider.

EXERCISE.—Pick out terms and relations in the following pairs of premises. Draw the conclusion permitted in each case.

1. Roosevelt was a hunter of big game.
   Roosevelt was a president of the United States.

2. Yuma is named after the Yuma Indians.
   The Yuma Indians inhabited the lower valley of the Colorado River.
3. John struck his little brother.
   Anybody who strikes his little brother is punished.
4. John struck his little brother.
   His little brother had torn his book.

In the fourth place, while the propositions which have been heretofore used for illustration are all propositions containing but two terms and one relation, it is to be noticed that a proposition is not necessarily of this simple structure. There may be three, four, or more terms, and a corresponding complexity of relationship. Such propositions are not very common in deduction, and they interpose no special difficulties in the study of the principles of correct inference, but for the sake of completeness of analysis the fact must be mentioned. Consider the following syllogism: **Complex propositions**

> Father told Robert to bring the paper.
> Robert is my older brother.
> Therefore, father told my older brother to bring the paper.

By a violent transformation of the first premise—Robert is one told by father to bring the paper—it may be construed as containing only two terms in a single relation. But such twisting is obviously unnatural. As it stands, the premise contains three terms and two relations, and there is no difficulty in advancing by the other premise to the proper conclusion without any change in the form of statement at all. And if we add to this premise the phrase "on the hall table," we introduce another term and another relation without adding any strain to the process of reasoning necessary to complete the deduction.

Exercise A.—Analyze the following into terms and relations, assigning as large a part of the proposition to the relation as possible.

1. Helen is prettier than Caroline.
2. The waves of the sea are deep blue.
3. My copy of *Omar Khayyám* is under the shelf.
4. The world is too much with us. (Observe that "too much" modifies the phrase "with us".
5. This knife is just as sharp as that.
6. Amundsen discovered the South Pole.
7. Daniel Boone fought the Indians.

8. A piece of the shell hit Wilbur's jaw.
9. No truth is wholly painful.
10. Some birches are longer lived than others.
11. A few students were tardy.
12. All the boys in my class are taller than the girls.
13. $x + y = \frac{z}{5}$.

B. Arrange the following syllogisms in the form necessary to identify terms and relations in each proposition:

1. I shall not all die, for love and reason are immortal.
2. Deep lies the snow in the forest, hence it will not melt quickly.
3. All trespassers will be prosecuted. Prosecution is an annoyance. Therefore all trespassers will suffer annoyance.

### *Section 4.* THE FUNDAMENTAL STRUCTURE OF THE SYLLOGISM

What the syllogism really does

Returning now to the syllogism as a whole in the light of the analysis of its elements, we are in a position to complete our study of its fundamental structure. We observed that one term is common to the two premises, and that this term is the one omitted in the conclusion. That is, the other terms become related in a certain way in the conclusion by having been successively related to this (now omitted) term in the premises. The term which thus binds the premises and enables them to yield a conclusion about the other terms is called for this reason the *middle term;* the others are the *subject term* or the *predicate term,* according to their position in the conclusion. The subject term is sometimes also called the *minor term* and the predicate the *major term.* No special terminology has become technical for cases where the conclusion contains three or more terms.

But the central question which still needs to be asked is, what happens to the relations asserted in the premises as we pass to the conclusion? The answer is, of course: The relations are combined in accordance with their meanings to form a single relation in the conclusion. This is clear from the illustrative syllogisms with which we are now familiar. But in order to discover more clearly the laws according to which relations are thus combined the student must experiment with syllogisms in which the terms have been replaced by neutral symbols. Thus we avoid distraction by the terms and the rela-

tions are brought into full prominence. The following will exemplify the method suggested:

If A is greater than B, and B greater than C, then A is greater than C.

If A is in tune with B, and B is in tune with C, then A is in tune with C.

If A is north of B, and B is west of C, then A is northwest of C.

If A is brother of B, and B is brother of C, then A is brother of C.

If A is father of B, and B is father of C, then A is grandfather of C.

If A is as old as B, and B is older than C, then A is older than C.

If all A is B, and all B is C, then all A is C.

If no A is B, and some C is A, then some C is not B.

If all A is B, and some C is A, then some C is B.

If A explored B, and B is (identity) C, then A explored C.

If A is descendant of B, and B is descendant of C, then A is descendant of C.

If A is writer of B, and B is (inclusion) C, then A is writer of one (or some) C.

If A happened earlier than B, and B happened earlier than C, then A happened earlier than C.

If A is $\frac{2}{3}$ B, and B is $\frac{1}{6}$ C, then A is $\frac{1}{9}$ C.

If more than half A is B, and more than half A is C, then some B is C.

Symbolic representation of the structure of the syllogism

Generalizing from such a study, we may formulate the structure of the syllogism in a symbolic scheme as follows:

$$\begin{array}{r} A\ (R_1)\ B \\ B\ (R_2)\ C \\ \text{Therefore, } A\ (R_1R_2)\ C. \end{array}$$[1]

That is, B is the middle term, and since A stands to it in the relation $R_1$ in one premise, and B itself stands in the relation $R_2$ to C in the other, the conclusion asserts that A stands in the relation $(R_1R_2)$ to C, the symbol of relation here expressing the organic unity of $R_1$ and $R_2$ in a single relation in accordance with their meaning. Every valid syllogism of three terms must conform to this essential structure. The student will find it interesting to work out for himself a symbolism for cases where one premise contains more than two terms.

[1] I owe this formula to my former teacher, Professor Montague of Columbia University.

This process depends on the nature of meanings

What is it that makes the passage of implicative thinking thus analyzed and symbolized possible? The only uncontested answer to such a question is the remarkable fact of *meaning*, and that meanings can really be analyzed and combined in ways which they themselves dictate. Furthermore, it is clear that to think as we human beings do think is to live in a world whose objects have meaning, and are related in the ways which deduction reveals. If we ask how meanings are possible, there is great disagreement as to whether the question is an intelligible one, and if it is, what kind of answer can be appropriately given. Or, to put the question in the more particular form which it tends to take in present discussions: Is a genetic or evolutionary account of the development of meaning out of something prior and simpler an adequate explanation of it? —and again philosophical schools diverge widely in the answer offered. Fortunately, we do not need to enter such debates. We have pointed out that meanings as used in real problems reveal certain analogies with the more overt reactions of the so-called lower animals, without prejudging the question whether meaning in its intrinsic nature can be derived from such reactions by an evolutionary process, or whether it involves an element that cannot be thus genetically explained. The foundation for logic is simply the fact that terms and relations as used in the fourth step of an act of thought do have meaning, and that their meanings bind them together in various ways in an implicative system, some aspect of whose structure is revealed whenever we pass from premises to their deduced conclusion. The meanings of "animal" and "dog" are such that we can state certain things about them with full confidence, such as: "All dogs are animals," "Some animals are dogs," "No dog is not an animal," etc., and use these relations of inclusion and exclusion between the terms in any piece of reasoning to which they may be pertinent. Similarly, the meanings of relations are such that they can be combined in various ways to form new relations, whose nature is determinately constituted by the relations that enter into them. The meaning of "father of" is such that if X is father of Y, and Y father of Z, then

X must be grandfather of Z; that is, the relation "father of" combines with itself to make "grandfather of." Again, the meanings of "equal to" and "greater than" are such that if A is equal to B and B greater than C, then A must be greater than C; the two meanings are determined in their own nature to combine in just this and no other way.

Meaning is, indeed, a wonderful thing. It is the correlate, in the objective world, of that capacity in ourselves that we call intelligence.

Summary of the fundamental conditions of a valid syllogism

As a summary of the analysis of the present section, we are now in a position to state what the fundamental conditions of correct reasoning, or of a valid syllogism, are. Speaking first in general terms, these conditions are: (1) *A clear grasp of the meanings which in any given piece of reasoning we are using, and* (2) *faithful adherence to them throughout the reasoning.* But our analysis of terms and relations as functioning in syllogisms enables us to put these conditions in more specific form. We shall state these in the three following rules, which are derived from the above discussion and which apply to all deductive inference:

1. The meanings of both terms and relations must remain unchanged throughout the deduction.
2. The conclusion shall contain only those terms which the premises have successively related to a middle term.
3. The relation asserted in the conclusion must be that produced by the union of the relations asserted in the premises.

The student will verify these rules by a comparison of the valid syllogisms used as illustrations with attempted deductions which violate them. As regards the types of deduction with which logic is expected to deal in detail, we shall illustrate these rules and their violations when we devote ourselves to a thorough study of such types.

Need of analysis of meanings on a simpler level than that of the syllogism

Now at this point we might pass at once to a classification of syllogisms in accordance with the type of relation which they reveal, and to a study of the specific problems which certain syllogisms suggest. But with the fundamental fact of meaning before us, and its importance for reasoning appreciated, it will

be best to postpone such a classification while we gain some practice and discipline in the analysis of meaning implications on a somewhat simpler scale than that of the syllogism itself. We can accomplish this by a study of the problems how to define terms accurately, how to classify both terms and relations exhaustively, and also by a more detailed study of what was described above as immediate inference. These studies not only have the virtue of familiarizing us with the implication of meanings on a somewhat simpler level than that of the syllogism itself (though it must be remembered that the entire syllogism is always the unit of real deduction), but will also help to strengthen the habit of insistence on clear and exact grasp of meanings and on rigorous faithfulness to them in one's reasoning—the essential virtues which underlie correct thinking at the fourth step.

## *Section 5.* DEFINITION AND CLASSIFICATION

Definition

Let us turn, then, to the problem of defining terms. Consider the following definitions, as given in *Webster's Dictionary:*

Man is the animal with the power of articulate speech and the capacity of abstract reasoning.

Nausea is any sickness of the stomach with a desire to vomit.

Research is careful, critical inquiry in seeking facts or principles.

Temperature is a condition with respect to heat or cold.

Virgo is a zodiacal constellation, containing the bright star Spica, situated on the celestial equator, due south of the handle of the Dipper.

Gas is an aëriform fluid, having neither independent shape nor volume, but tending to expand indefinitely.

It is evident that the general intent of these definitions is to fix the meaning of the words defined, so that we may know precisely what we are talking about when we use them, that different people may mean the same thing by the same word, and that it may be easier to use the words consistently—*i.e.* to avoid introducing changes in their meaning. They thus secure more explicitly the ends which to some extent must be secured if we are to reason at all. But there are three important points to be observed in connection with the making of definitions.

The first is that any helpful definition of a word which cannot be replaced by a simpler exact synonym is stated in terms of a more general class, including the class it denotes, and sufficient differentiating characteristics to identify it from other objects that are also included in the more general class. Thus the definition of "man" first uses the term "animal," denoting a class which includes man along with many other creatures, and then adds those peculiar marks of man that enable us to distinguish him from other animals. In this case the power of articulate speech and the capacity of abstract reasoning fill this function. Similarly, temperature is defined first by the very general term "condition," and then by such a phrase as serves to identify it by contrast with other conditions—"with respect to heat or cold." Likewise research is affirmed to be an "inquiry into facts or principles" that is different from other such inquiries by being careful and critical. Now the technical term for the more inclusive class under which the definition places the word to be defined is *genus*, and in relation to such a more inclusive class the word defined denotes one of its *species*. Thus in the first definition man is a species of the genus animal; in the second, nausea is a species of the genus sickness of the stomach, and so on. Students familiar with biology will have no difficulty with these concepts, only it must be remembered that they are entirely relative—that is, that what is genus in one definition may be a species in another. If we wished, for example, to define "animal," we should do so by placing it in some more inclusive genus, of which it would constitute one species, whereas in the definition of man it plays the function of genus itself. The rest of the definition is known technically as the *differentia*—namely, the part which seeks to distinguish the term defined from other species of the same genus. State genus and differentia in each of the above definitions, and suggest in the case of each genus a more inclusive class in relation to which it would be a species. Genus and differentia

An interesting question is apt to occur to the student in connection with the hierarchy of classes which this relativity of genus and species implies. Can a more inclusive class always be found for any given class, or a less inclusive one to be placed Limits of the relativity of genus and species

under it? This is properly a metaphysical problem, and is not easy to answer, but for logical purposes it is safe to answer no in both cases. In the direction of greater specificity we sooner or later come upon that which logically functions as an individual and not as a class at all. "Virgo" in the fifth definition above is a case in point. If we wished to define one of the stars in Virgo we should not do so by treating Virgo as its genus, for both are individual objects. In the other direction, we sooner or later come upon classes so abstract and inclusive that it is impossible to find any proper genus for them. "Entity" and "thing" are such classes. It is the task of ontology, one of the branches of metaphysics, to determine the number and significance of such ultimate abstractions.

**Extension and intension of terms**

It is to be observed, also, that such inclusive concepts are in the nature of the case indefinable after the manner of other concepts. Hence the meaning can be gathered only from the way in which they are used to define more limited classes. This suggests that the concrete source of the meaning of any concept must be something other than the more abstract concept in terms of which it is defined, for in the end the more abstract itself can gain significance only from the less abstract which it includes. This source is simply the individual objects or groups, which can be pointed to in experience as those *named* by the term. Now the reference of a concept to the objects which it names is known as its *extension* or *denotation,* in contrast with its *intension* or *connotation,* by which is meant its definition in terms of genus and differentia. Apart from such concrete objects and the activity of thought in reasoning about them, class concepts at any level of abstraction would have ultimately no meaning.

**Formal rules of correct definition**

Beyond distinguishing genus and differentia as above described, logicians usually state certain rules which must be observed if the general purposes of definition are to be secured. Those which need to be noted are the following:

1. Definitions should not be circular—*i.e.,* they should not contain a mere synonym of the term defined. This rule need not be adhered to when the term can be adequately

explained in terms of a simpler and exact synonym, as "impecunious" by "poor."

2. Definitions should not be in terms less familiar than the term defined. To violate this rule is to explain *ignotum per ignotius*. This does not apply, however, to the definitions of exact science when considered from the point of view of common folk unfamiliar with scientific terminology. A large part of the task of science is to replace loose colloquial definitions by more technical ones, for the former are usually vague and lack consistency.
3. The differentia must clearly distinguish the term defined from all other species of the same genus.
4. The definition should be affirmative rather than negative —that is, in terms of positive meanings. Notice, however, that it may be negative in form while positive in meaning, as in the definition of a bachelor as an unmarried man.

It will be observed that these are simply corollaries of the purpose and form of a definition. Let the student demonstrate them to be such.

EXERCISE. Criticize the following definitions in the light of the above rules:

1. A net is a reticulated texture with small interstices.
2. Oats are a grain which in England is given to horses, but in Scotland supports the people.
3. A good man is a man who can be counted upon to do the right thing.
4. Man is a two-legged animal without feathers.
5. The king is the voice of God on earth.
6. The king is the self-appointed oppressor of his country.
7. God is the Divine Being.
8. Fun is frolicsome amusement or merriment.

**Definitions as dependent on the purpose in making them**

The second important point is this. There is no one definition which is the indubitably correct one for a given term, but the definition will take various forms, depending on the main purpose in making it. This was not realized in the triumphant era of formal logic in the Middle Ages, when it was believed that the hierarchy of relations between genera and species developed

by the dominant thinkers of the time was absolute. This assumption was doubtless due to the fact that during the Middle Ages there was general agreement among those in authority as to the ultimate purpose of life, and the relation to it of such intellectual activity as expressed itself in the framing of definitions; accordingly, this accepted teleology controlled without question the formation of the hierarchy. But when disagreement on such ultimate purposes becomes prevalent and gains frank expression, as in the modern world, the relativity of definitions to the purpose in making them becomes quite evident, and considerations can no longer be neglected which were easily slurred over by the schoolmen.

**Consequence of this for the differentia of a definition**

This relativity of definition to purpose does not always mean that different definitions of the same term will place it in a different genus, for since the genus is more general in meaning than the species, inclusion in a single genus may help define a term for varied purposes. But the differentia will be different whenever the purpose is definitely different; indeed, we may now describe the differentia more concretely and less formally than before by saying that it states those characteristics of the thing defined which will enable it to be used as a means for the purpose in hand. Thus suppose one wished to define "oats" from the standpoint of the botanist, from that of the farmer, from that of the miller, and from that of the cook. All these definitions would very likely use the same genus, namely "grain." But the differentia would differ greatly; in fact, that of any one of them would not be directly helpful to any of the others. The botanist would pick out those characters of the oat which enable him to locate it in its evolutionary relations, for it is in terms of such relations that he can most easily organize and unify the whole field of material with which he deals. The farmer would pick out those characters which indicate whatever special treatment is necessary in order to grow oats successfully, treatment which does not need to be borne in mind when growing other grains. Similarly, the differentia of the miller would indicate the particular processes required to prepare oats for the market, and that of the cook the particular methods needed to turn them into food for the table.

To affirm that there is only one proper definition of "oats" would be to affirm that only one (or perhaps none) of these purposes is legitimate, which would surely be high-handed procedure.

For the genus

But in many cases a difference of purpose would imply not only a different differentia, but also a different including genus. Take "painting" for example. From the standpoint of the artist or of one absorbed in esthetic enjoyment, the genus would probably be "work of art" or some synonym; if its creator is one of established reputation, his name itself would perhaps be used as the genus—as we say, "This is a Titian," "That is a Rembrandt," etc. But from the standpoint of the house decorator, the genus would be "wall-furnishing," or some term that would similarly reflect his special interest. In the same way, a definition of oxygen made by a chemist would probably differ in respect of both genus and differentia from one made by a physiologist.

The purpose of scientific definitions

Naturally, the most widely useful definitions are those which reflect the more common purposes with the things defined. Consequently, it is usually a waste of time to devote much effort to the attempt to develop exact definitions where the controlling purpose is very specific and perhaps unlikely to occur again. On the other hand, while it is impossible to frame a definition of anything that will identify it completely for all important purposes, it is possible to develop a kind of definition that will partially identify it as a means to many different ends, and which, therefore, demands for its completion only a statement of the end in question. It is one of the tasks of exact science to establish definitions of this sort, definitions in terms of relations so fundamental that the achievement of any purpose with the objects defined must take account of them. But to achieve such a result fully is to attain the utmost goal of scientific advance; at present we can only affirm, on comparing the best scientific conceptions with, say, those prevalent in the Middle Ages, that we have made vast strides toward it. An illustration will make this clear. The mechanical conception of gravity tells us far more about what can be done with a material object than

the mediæval notion that it "seeks its proper place," but, not including all the characters of the object in all its relations, it does not give us the complete control over it for all purposes that constitutes the ideal goal of science. And the same applies to any scientific analysis.

EXERCISE.—A. Describe the purpose which seems to be expressed in the following definitions, and state other purposes in terms of which definitions might have been couched:

1. The mosquito is the most usual instrument of the dissemination of malaria.
2. The pearl is a dense, shelly concretion, formed as an abnormal growth in the shell of some mollusks.
3. Severe headache is the illness which most completely incapacitates for mental work.
4. Rent is the landlord's source of income.
5. Space is room in which objects can move.
6. Winter is the season in which the noonday sun shines most obliquely.
7. Insanity is such unsoundness of mental condition as precludes responsibility for one's actions.

B. Define:

1. "Box" from the standpoint of the carpenter; from that of the shipper.
2. "Ice" from the standpoint of the physicist; from that of the skater; from that of the ice-cream manufacturer.
3. "Church" from the standpoint of the historian; from that of the minister; from that of the statesman.

Be sure to distinguish clearly definitions of the same object viewed from different standpoints from definitions of different objects with the same name. For example, the church which has just been mentioned is, of course, the social institution of that name; the term is also used in another sense to describe the type of building in which center the activities of that institution.

**Relativity of definitions to the state of knowledge reached**

In the third place, it is important to observe that definitions are relative in still another sense. They depend on the stage of development of knowledge about the objects in question. The scientific achievements of the past are funded in the definitions which we make use of in our present thinking. And, as already noted, education in the sense of communicating information is important because it is by means of it that the accumu-

lated knowledge of the race at any given time, as distilled in the most exact definitions available, is made the active capital of the growing generation. But no definition is final, because knowledge about anything is never as complete as we have reason to expect that it might be. Moreover, the widespread tendency to regard some definitions as absolute and incorrigible is the chief hindrance to the supplanting of inadequate definitions by better ones, ones that would enable us to deal more successfully with the objects defined. To form the habit of tentativeness with reference to our formulated knowledge is therefore essential to logical thinking. Tentativeness, be it noted, does not mean scepticism, nor impotent hesitancy when decisions are required. It means readiness to stake all on the best knowledge now available, coupled with readiness to see that knowledge replaced by more exact formulations.

Compare, for example, the modern scientific definition of malaria with the best definition that could be offered before the germ theory of disease had been conceived and verified in the case of malaria. In both cases the guiding purpose is the same —to cure the disease—but the definitions are very different. The modern doctor defines malaria as the presence in the red blood-corpuscles of animal parasites of the genus Plasmodium, because modern science has discovered that the essential requirement for the cure of the disease is the control and elimination of these parasites. By the aid of such knowledge whole communities have been freed from malaria in which formerly it was a most destructive scourge. But before the discovery of these parasites the disease could only be defined in terms of its external and rather accidental symptoms, which gave no basis for confident control, or (still worse) in terms of an erroneously supposed cause, such as the entrance of poisonous exhalations from the soil. It is highly probable that even our present medical knowledge but marks the merest infancy of the science in comparison with the degree of control which may be attainable in the course of future scientific research. Hence it is of the highest importance that we accustom ourselves, in all fields of science, to hold definitions as tentative merely—the best available founda-

tion for action, but yet to be surrendered at once in favor of others which enable us more widely or securely to solve our problems.

The nature of classification

Classification we shall discuss more briefly. It is intimately associated with definition, and affords the same practice in making meanings explicit. We noted that exact definition is always in terms of genus and differentia (controlled by a certain purpose with the objects defined), and that the differentia states the characteristic marks by which the species defined (again in the light of the functioning purpose) can be clearly distinguished from other species of the same genus. A genus was thus revealed to be always a more inclusive class, containing various species under it. This fact suggests the problem of classification. How shall we divide a given genus into its species in such a way that the latter are mutually exclusive and at the same time, taken all together, exhaust the entire field covered by the genus? Or, in short, how shall we determine the exact meaning of the genus in terms of the more limited and concrete species which constitute its extension?

Inadequacy of classification by dichotomy

The older logic attempted to do this in quite unimpeachable form by a type of division known as *dichotomy*—that is, by the analysis of any given class into two subclasses so stated as, formally at least, to gain the ends of exhaustiveness and mutual exclusion. This method is illustrated in the following table:[1]

Substance

Material Nonmaterial

Organic Not-organic

Mineral Not-mineral

Gold Not-gold

[1] Creighton, J. E., *An Introductory Logic,* p. 78.

But what use can we make of such a classification? Aside from revealing the interrelations of a few concepts, it has no practical value. In order to make clear the meanings of these terms in relation to the concrete objects and sub-groups which are supposed to be referred to by them, it is obvious that we must replace the purely negative classes nonmaterial, not-organic, etc., by positive equivalents, whose exact range of denotation can be determined. The attempt to do this is to classify in the more common and fruitful sense of the term. It is more difficult to carry out, but essential for the ends of classification. Such a classification is intended by the division of the genus "race" into Caucasians, Negroes, Mongolians, Malays, and red Indians. Each of these species is supposed to exclude the others, and all taken together to exhaust the genus.

**Dependence of classification on purpose**

Before we state the rules which must be obeyed by a logical classification, it must be remembered that inasmuch as the definition of a species will vary according to the purpose in hand, so the classification of a genus will vary according to the purpose. A simple illustration of this will be found in the several classifications of its patients which a hospital will make. They will be classified in accordance with their disease, with the doctor in charge, with the accommodations they are being given, with the alphabetical position of their last names, etc. Similarly, houses may be classified according to location, type of structure, number of rooms, market value, and in many other ways. Of course, here too it holds true that classifications reflecting the more common and persisting purposes with objects are more widely valuable than others.

**Rules of classification**

The rules may now be stated:

1. The controlling purpose must not be changed in the course of the classification. This would be violated if, for example, we should classify Americans into Whites, Negroes, Indians, business men, and professional men. Obviously, the purpose in this analysis changes from that of analyzing them according to the color of their skin to that of analyzing them according to their occupation.
2. The species into which the genus is divided must not

overlap but must be mutually exclusive. This rule is also violated by the above instance, for the last two classes overlap all the others.

3. The constituent species must, taken together, exhaust the genus. That is, no part of the genus must be omitted in the classification. This rule is also violated by the above instance, for in accordance with neither color nor occupation is the division complete.

EXERCISE.—Criticize the following classifications:

1. Books into quartos, octavos, duodecimos, and paper-covered.
2. Men into good and bad.
3. Animals into male and female.
4. Students into industrious, lazy, brilliant, and dull.
5. Philosophies into true and false.
6. Murders into premeditated, atrocious, and justifiable.
7. Europeans into Germans, English, Russians, Latins, Slavs, and Bolshevists.

Notice that many of these classifications suggest the difficulty and the great need of making many of our common terms more precise in meaning so that we shall know exactly whether they are mutually exclusive and whether a given list, taken as a whole, exhausts a genus or not. Is there, for example, a neutral middle ground between good and bad, and are not such terms relative to circumstances anyway?

Here, it will be observed, we have been dealing with the classification of terms merely. The same general principles apply to the classification of relations. But we shall take up their classification in detail in the place where it will be more serviceable, namely when we come to analyze the various types of syllogism.

## *Section* 6. FURTHER ANALYSIS OF THE PROPOSITION—IMMEDIATE INFERENCE

**Logical quantity**

Let us continue the consideration of meanings and the simpler types of implication which they make possible by a more detailed analysis of immediate inference, which, it will be recalled, consists in bringing to light the conclusions that can be directly drawn from a proposition without the aid of additional information. And our first task will be to turn to the

structure of the proposition once more, and note elements in it which would have unnecessarily complicated the analysis at the time our main interest was in discovering and distinguishing clearly terms and relations.

Consider the following propositions:

> All the boys in this class are taller than the girls.
> Eighteen per cent of the voters in this state are illiterate.
> Some New Yorkers are inhabitants of Long Island.
> No diagonal of a square is commensurate with its side.
> A few turkeys in this lot are not expensive.

What is the status logically of the words "all," "some," "no," "a few," "eighteen per cent of"? It might be thought at first sight that these can be construed as a part of the subject terms, but on closer inspection they are found to play a sufficiently unique logical function to deserve special consideration. They indicate of *how many* of the objects denoted by the subject term the relation to the predicate term is really asserted. That is, they are indicative of *logical quantity* in the judgment expressed. And logicians find it important to distinguish with special clearness those terms which indicate that the objects denoted by the subject term are *universally* asserted to occupy the relation to the predicate term from those which indicate that only a *part* of them are so related. Clearly, such words as "all," "every," "whatever," and the like, are signs of universal quantity in the judgment; they indicate that the relation is asserted of the entire group of objects denoted by the subject term without exception. On the other hand, "some," "a few," "eighteen per cent of," "nearly all," "the major part of," "three-fifths of," etc., just as clearly signify *particular* quantity; they affirm the relation in question of only part of the group of objects denoted by the subject term. It is to be observed that certain of these signs of particular quantity, such as "eighteen per cent of," "three-fifths of," are much more precise than the others in the information which they yield. Now propositions of the former type, in which the relation to the predicate term is asserted of all the objects denoted by the subject term, are *universal* in logical quantity; those of the latter type, in

which the relation is asserted of only part of them, are *particular* propositions in quantity. Before dealing with any proposition logically, it is important to note whether it is universal or particular, and if the latter, whether the quantity is vague or definite. For of course the implications of the proposition differ correspondingly.

A verbal sign of quantity not necessary

Wherever a verbal sign of quantity is used, as in each of the above propositions, this is quite easy. But there are cases where no such sign is present, and it is necessary to reflect a moment to make sure of the proposition's meaning with respect to quantity. Thus:

> Cats are fighting in our back yard

is evidently a particular proposition; it means some cats, not all cats. Whereas,

> Cats instinctively catch mice and birds

is universal. The relation is meant to be affirmed of all cats. If careful consideration of a proposition still leaves its quantity ambiguous, and comparison of the context gives no clear light, it must be treated as particular, so far as we cannot avoid treating logically such an ambiguous statement. For, as we shall see in a few moments, whatever is true of a universal proposition is true of the particular with the same subject, relation, and predicate, while what is true of the particular may not be true of the corresponding universal.

Singular propositions are universal

A case which sometimes causes confusion to students is that in which the quantity seems to be *singular* or *individual*. This may be illustrated by the following:

> Los Angeles is more populous than San Francisco.
> Socrates was an Athenian citizen.

What is the logical status of such propositions? The student is apt to make the mistake of calling them *particular*, for that is the way in which they are treated grammatically. But consideration will show that as regards logical quantity they must be universal. For since the subject term denotes something which is considered as a single or individual entity, the relation must be affirmed of the whole of it. Only when the

object is not considered as an individual, but with distinction of its parts, is it possible to affirm a particular proposition about it, as in the case:

Part of Chicago is north of the Chicago River.

If this point is remembered clearly, the student will have no trouble handling singular propositions.

Particular use of "all" and "every"

It should be carefully noted that universality and particularity are matters of the *meaning* of the proposition, and are therefore not infallibly indicated by any set form of words. This should be realized especially in the case of "all" and "every." These usually indicate universal quantity, but not always, as will be seen from the following instances:

All that glitters is not gold.
Every man that does such things is not a criminal.

Clearly these are both particular, not universal, propositions. The first is equivalent in meaning to: "Some things that glitter are not gold"; the second to: "Some men that do such things are not criminals." We may deplore such ambiguities of language, but when they have become rooted in common speech there is no way but to accept them and guard carefully against being misled by them. The way to do this is to form the habit of asking always what *meaning* the proposition is intended to convey.

Logical quality

Thus we find that propositions always have a logical quantity, that this quantity is either universal or particular, and that in the latter case the quantity is either vague or definite. But a second distinction must be made besides that in terms of quantity. Some of the above propositions *affirm* a relation of the subject to the predicate; others *negate* the relation. The latter are the two following:

A few turkeys in this lot are not expensive.
No diagonal of a square is commensurate with its side.

(Notice that the latter is equivalent in meaning to: "All diagonals of squares are not-commensurate with their sides.") Of these, one is universal, the other particular, but both negate the relation named instead of affirming it. This negation is

indicated by the particle "not," or by "no," which is equivalent to "all . . . not." That is, a few turkeys in the lot are *excluded* from the class of expensive things instead of included with them; the diagonal of a square is *denied* the relation "commensurate with" to its side. Now this character of a proposition by which it may be affirmative or negative is called its *quality*, and besides affirmative and negative there is no third possibility with respect to quality.

Bringing together now the quantitative and qualitative aspects of propositions, it is evident that any given proposition must come under one of these four heads: universal affirmative, universal negative, particular affirmative, and particular negative. To avoid the necessity of constant repetition of these categories, it is customary to symbolize them by the four letters, A, E, I, O (the first two vowels, respectively, of the Latin words *affirmo* and *nego*), as follows:

A universal affirmative proposition is an A proposition.
A universal negative proposition is an E proposition.
A particular affirmative proposition is an I proposition.
A particular negative proposition is an O proposition.

It is important to become so familiar with these symbols that a given proposition can be described at once, as to quantity and quality, in terms of them.

A proposition then has six elements

Our analysis of the structure of a proposition is now complete. Besides the four elements earlier noted, namely, subject term, copula, relation, and predicate term, there are always two others—sign of quantity and sign of quality. The proposition may be such that each of these six elements is represented by some specific verbal form, as in the case:

| | | | | | |
|---|---|---|---|---|---|
| Some of | the coins | are | not | in | the purse. |
| Quantity | Subject term | Copula | Quality | Relation | Predicate term |

Several of the elements may not be so represented, as in the proposition:

Ripe mangoes are delicious.

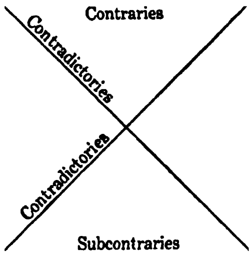
Here the quantity (universal) is understood from the general form of the statement; since the quality is affirmative, no special word is needed to indicate it; and the word "are" serves

as both copula and relation. But the six logical elements are always present, and must be present, in every proposition.

Immediate inference—the square of opposition

We are now prepared for a more detailed study of the relations of meanings as revealed in immediate inference.[1]

Immediate inference includes two main forms of implicative relationship. One is illustrated by what logicians have called the *square of opposition*. Its guiding problem is: Given a certain proposition, what is implied by it about propositions containing the same subject term, relation, and predicate term, but differing in quantity, quality, or both? Or, to put the question in terms of our symbols, what is implied by an A proposition about the E, I, and O propositions containing the same subject term, relation, and predicate term; what is implied by E about A, I, and O, etc.? The square of opposition represents these implications in the following manner:




Contradictory propositions

What is meant by these categories: *contrary, contradictory, subaltern,* and *subcontrary?* Let us begin with contradictory. To say that A and O are contradictories is to say that if either is taken as true, the other must be held false, and that if either is taken as false, the other must be held true. If, for example, it is true that: "All the pictures are on the wall," then it must be false to say that some of the pictures are not on the wall. If it is false, on the other hand, that all the pictures are on the

[1] For the purpose of this practice, it is assumed that examples of all the classes referred to exist. The elementary student need not be bothered as yet by the problem of the different existential import of universal and particular propositions.

wall, then it must be true that some of them are not on the wall. Likewise, if it is true that some of the pictures are not on the wall, it must be false to say that all of them are there; if it is false that some of them are not on the wall, it accordingly follows that all of them are there—that is, that the A proposition is true. The student may analyze in similar fashion the contradiction between E and I.

Contraries and subcontraries

A and E are contraries, not contradictories. This means that if either is taken to be true the other must be held false, but that both may be false. That is, it is impossible to argue; as in the case of contradictories, from the falsity of one to the truth of the other. Thus, if it is true that all the pictures are on the wall, it must be false to say that none of them are on the wall. Similarly, if the latter proposition is true, the A proposition cannot be true. But if we know it to be false that all the pictures are on the wall, we can only affirm that some of them are not there; we cannot assume that none of them are there. For it is obvious that some might be there, and some not. The same, of course, holds with reference to A if we assume E to be false.

In the case of subcontraries the reverse situation obtains. The falsity of one implies the truth of the other, but the truth of one does not imply the falsity of the other, for both may be true. Thus, if it is false that some of the pictures are on the wall, it must be true that some are not there—indeed, we know more, that all of them are not. But if it is true that some of them are on the wall, we cannot hold the O proposition to be false, for evidently some might be there, and some not.

Contrary and contradictory fuse in singular propositions

It is important to note that no distinction can be drawn between contrary, contradictory, and subcontrary in the case of singular or individual propositions, for to speak of the subject of such a proposition at all is to speak of the whole of it. Here, then, the only opposition is between affirmation and negation; consequently, each must be the full contradictory of the other. If Socrates is the wisest man in Athens, then it must be false to say that he is not the wisest man in Athens; also, if it is

false to hold him the wisest man in Athens, it follows that the proposition that he is not the wisest man there is true.

Subalternation

The other relation, that of subaltern, is simple and clear, but there is one point about it not represented in the square of opposition which is worth observing. It is clear that whatever is true of a universal is true also of the particular of the same quality, but that what holds of the particular may or may not hold of the universal. Thus, if it is true that all the pictures are on the wall, it must be true that some of them are on the wall; but if we know that some of them are there, whether all of them are or not is indeterminate. In common speech we often use "some" as implying "some, but not all." This is not, however, its exact logical meaning; that is: "some, at least, whether all or not we do not know." Hence, if I is true, A must not be said to be false, but indeterminate. It is also clear that if the particular is false, the universal must be false, too, but if the universal is false the particular may or may not be true. If "some of the pictures are on the wall" is false, then it is surely false to say that all of them are on the wall; but if the latter is false it does not follow that some of them may not be there. The student may work out the relations between E and O in similar fashion.

Relations of greater and less quantity in particular propositions

Now the additional point to be noted, not represented on the square, is that where indications of particular quantity are precise enough to reveal differences of greater and less within the particular itself, exactly the same relations hold between the greater and the less as hold between the universal and the particular. Thus if it is true that "most Christians are not Orientals," it must also be true that "some Christians are not Orientals." If "sixty per cent of the voters of this county are illiterate" is a true statement, then it follows that thirty-five per cent of them are illiterate. Though, of course, when we use such figures as a result of a scientific investigation, we should rarely have occasion to substitute a smaller figure when we have demonstrated the greater. The student may demonstrate for himself the other subaltern relations in these cases, such as the impossibility of arguing from the falsity of the greater to the falsity of

the less, or from the truth of the less to the truth of the greater. These are, however, fundamentally, but matters of simple arithmetic.

EXERCISES.—1. Given as true the proposition, None of the food is spoiled, are the following true, false, or indeterminate?
a. Some of the food is spoiled.
b. Most of the food is not spoiled.
c. All of the food is spoiled.
d. Half the food is spoiled.

2. Given as false the proposition, Some service is not voluntary, what is implied about the following?
a. No service is voluntary.
b. Some service is voluntary.
c. All service is voluntary.
d. Most of the service is not voluntary.

3. Given as true the proposition, Two-thirds of all beggars are fakes, what follows about:
a. Some beggars are not fakes.
b. Twenty-five per cent of beggars are fakes.
c. Sixty per cent of beggars are not fakes.
d. All beggars are fakes.
e. No beggar is a fake.
f. A third of the beggars are not fakes.

(Notice that the original proposition does not say, Two-thirds only are fakes.)

4. By what relation do we pass from each of these propositions to the one which follows it?
a. All turkeys are more expensive than ducks.
b. Some turkeys are more expensive than ducks.
c. No turkeys are more expensive than ducks.
d. All turkeys are more expensive than ducks.
e. Some turkeys are not more expensive than ducks.
f. Some turkeys are more expensive than ducks.

5. Given as true the proposition, Most of the days in the dry belt are clear, what follows as to:
a. All days in the dry belt are clear.
b. No day in the dry belt is clear.
c. Most of the days in the dry belt are not clear.

(Remember that "most" means "more than half.")

d. Some of the days in the dry belt are not clear.
e. Some of the days in the dry belt are clear.

The other type of immediate inference involves the processes of *conversion, obversion,* and *contraposition.* The problem which the analysis of these processes seeks to answer is: Given a certain proposition as true, what other propositions are implied which have the same meaning (one exception to this will be noted), but which differ from it in quality or by interchanging the position of subject and predicate terms? [1] To change thus the order without changing the quality is to *convert* the proposition; to change the quality without changing the order is to *obvert* it; to change both is to *contrapose* it.

Immediate inference of the second type

Let us begin with conversion, as illustrated in various types of relationship. Consider the following examples of conversion (∴, it should be noted, is the logical symbol for "therefore"):

Conversion

Some of these boys are equal in height to some of the girls.
∴ Some of the girls are equal in height to some of the boys.

Some students are eager to learn.
∴ Some of those eager to learn are students.

Some of the books are above the magazines.
∴ The magazines are below some of the books.

No part of Colorado is west of any part of Utah.
∴ No part of Utah is east of any part of Colorado.

Six is greater than five.
∴ Five is smaller than six.

Some men are not wiser than some women.
∴ Some women are not less wise than some men.

John deceived Harry.
∴ Harry was deceived by John.

No Mohammedan army conquered Britain.
∴ Britain was not conquered by any Mohammedan army.

These examples illustrate the conversion of A, E, I, and O

[1] Applying these terms to other relations than that of inclusion, I find it desirable to define them in this fashion rather than in the strictly orthodox way. This permits freedom from certain restraints of the older definition, as will be seen below.

propositions. The implied proposition means exactly the same thing as the proposition which implied it, but the subject and predicate terms change places. Notice that the examples fall into two types as regards the relations involved. In the first two the relation undergoes no change in the course of the inference. Relations which undergo no change when the proposition in which they occur is converted are known as symmetrical relations. We shall soon have occasion to examine them more fully. Further examples are:

John is the strongest boy on this street.
∴ The strongest boy on this street is John.

No beggars are admitted.
∴ None of those admitted are beggars.

Converting the relation of inclusion

The relation of inclusion is ambiguous with respect to symmetry. In the I proposition it is symmetrical, as in the case:

Some plants are indigestible.
∴ Some indigestible things are plants.

In the A proposition it is not symmetrical, but propositions of this form can be converted by limitation only—that is, they lose their universality and become particular. This is evident if we take an example. "All men are mortal." Clearly we cannot infer from this that all mortal creatures are men. The original statement might be true, and this statement not be true at all; in fact, we see that it is not. For other animals, and plants, too, are mortal. But it would follow that *some* mortal creatures are men, for the original proposition stated that men are a class included within the class of mortal creatures. If we convert it in this way, however, the universality is lost, and should we be given the proposition, "Some mortal creatures are men," it would be illegitimate to convert it to "All men are mortal." For that would assume additional knowledge which the given proposition did not contain. The relation of inclusion in the A proposition, then, can be converted only by limitation.

With regard to the relation of exclusion, the fact that it is symmetrical indicates that theoretically the O proposition can be converted as readily as the E. To do so, however, involves

using a different form of words, and in fact we rarely do express our thought in that form. The original emphasis is apparently the one we wish to make, and the form is simpler.

Some of these berries are not ripe.
∴ All ripe things exclude some of these berries.

Procedure in converting other relations

The relations used in the other illustrations are asymmetrical. And the procedure of conversion in their case is equally simple. The relation in the converted form is merely the reverse in meaning and direction of that in the original form. "Greater than" becomes "less than," "wiser than" becomes "less wise than," "east of" becomes "west of," "above" becomes "below," "deceived" becomes "deceived by." The student should experiment with a list of other asymmetrical relations, discovering the relation which is the exact reverse in meaning to each.

Obversion

Study the following illustrations of obversion:

A is equal to B.
∴ A is not unequal to B.

Man's instincts are similar to those of the lower animals.
∴ Man's instincts are not dissimilar to those of the lower animals.

No crow is white.
∴ All crows are of other colors than white. (Notice we cannot say, black.)

Mary kissed John.
∴ Mary did not fail to kiss John.

Sacramento is east of San Francisco.
∴ Sacramento is not west of San Francisco, nor on the same longitude.

Truth is stranger than fiction.
∴ Truth is not less strange than fiction, nor equally strange.

All dogs bark.
∴ No dogs are creatures that do not bark.

Half of these eggs are not edible.
∴ Half of these eggs are inedible.

Most parents are responsible.
∴ Most parents are not irresponsible.

This stone is in line with that.
∴ This stone is not out of line with that.

The problem here is to transform an affirmative proposition to a negative one having the same meaning, or a negative to an affirmative. Notice that the only change in this process permitted to the terms is that they may have to be replaced by their logical opposites. Thus, "white" is replaced by "of other colors than white," "bark(ing animals)" by "animals that do not bark," "edible" by "inedible," and "responsible" by "irresponsible." This makes it always possible to get back the original proposition by obverting again.

Observe now that in general, when the relation of the original proposition is symmetrical, the change of quality is accomplished by negating the contradictory relation—"equal to" becomes "not unequal to," etc. In the case of the relation of exclusion this may require a little complexity of wording if the conclusion is not to sound artificial, as in the third case above, though where our resources of language are better the obversion is very simple, as in the eighth case. No general principle can be laid down in this respect about asymmetrical relations. Sometimes (often in the case of the relation of inclusion, as "All animals are mortal" = "No animal is immortal") the process is quite simple. At times, however, our resources of language are not varied enough to enable us to make the change without a good deal of circumlocution, and the obverted form would only very occasionally be used in actual speech or writing, when an unusual emphasis happened to be required. Particularly is this the situation with those relations that constitute a series, which we shall soon have occasion to study more fully. Here the exact negative form seems rather awkward. The full negative of "greater than" is not "less than," but "neither less than nor equal to"; of "stranger than" is not "less strange than," but "neither less strange than nor equally strange," etc. In other words, in these cases the possibility of equality in the respect in which the terms are compared always constitutes a third alternative. Equally awkward, perhaps, are obversions of some other relations. "Mr. X is the author of this book"

becomes "Mr. X is none other than the author of this book." It would be easier to regard "author of" as part of the predicate term, and the relation one of identity.

The student will observe that in all these obversions we proceed by the assumption that two negatives are equivalent to an affirmative in meaning.

Contraposition combines the changes of both conversion and obversion, the quality of the proposition and the order of the terms both being transformed. Examine the following instances of the process: **Contraposition**

All our employés are reliable.
∴ No unreliable persons are our employés.

Some medicines are not safe.
∴ Some unsafe things are medicines.

No triangle has four sides.
∴ All foursided figures are figures that are not triangles.[1]

The book is on the shelf.
∴ The shelf is not in any other position than under the book.

William is older than Paul.
∴ Paul is not older than William, nor of the same age.

The violin is in tune with the piano.
∴ The piano is not out of tune with the violin.

Evil is what causes pain.
∴ Nothing that does not cause pain is evil.

No further difficulty is involved in this process beyond those

[1] I realize, of course, that contraposition of the E proposition is not permitted by the older logical theory. But I see no compelling reason why it should not be possible to follow the order in this case of converting first and then obverting. In symbolic form the procedure is:

No A is B No B is A All B is non-A.

There is no difficulty in contraposing this back to its original form by using the other order:

All B is non-A No B is not-non-A, or,
No B is A No A is B

The irregularity is the occurrence of non-A as the predicate term. But what is ruined by allowing this?

already taken account of in the comments on conversion and obversion. Some little practice, however, is often required before we gain familiarity and ease in performing the process. The best way at first is to perform the two steps separately. After a while the knack will be gained of combining the two changes simultaneously. The fundamental points to be remembered are that the inferred proposition must have the same meaning as the original, that the quality is to be changed, and that the order of subject and predicate terms is reversed. This means that sometimes the new subject is the logical opposite of the old predicate, or the new predicate the opposite of the old subject. This is the case in examples one, two, three, and seven above.

Logical meaning of "alone," "only," etc.

Some are apt to find a certain difficulty in interpreting correctly the meaning of propositions containing the words "alone," "only," "all but," "except," etc. What, for instance, is the meaning of "Only employés are admitted"? A little consideration will reveal that this can be expanded to "None who are not employés are admitted." But this is the contrapositive of "All who are admitted are employés," and when contraposed itself will yield that as the result. Accordingly, the simplest way of stating its meaning is to make an A proposition whose subject is the original predicate. "Alone" can be treated in precisely the same way. "Men over thirty-five alone are eligible" equals "All who are eligible are men over thirty-five." "All but" and "except," on the other hand, can be rendered most simply in the negative form, unless they are already connected with the sign of negation.

> All but children may enter.
> None who may enter are children.
>
> Except ye be born again ye cannot enter the kingdom.
> All who can enter the kingdom are born again.

It will be found good practice to analyze the meaning of the term "unless" in similar fashion.

EXERCISES.—1. Convert, obvert, and contrapose each of the following propositions:

a. One is better than nothing.

b. No servants are satisfactory.
c. Most of these students are not interested.
d. Some books are popular.
e. Mr. Z was the founder of this university.
f. Mary is as brilliant as Louise.
g. Madison is west of Lake Michigan.
h. Coolidge is President of the United States.

2. Name the process or relation by which we pass in inference from each of these propositions to the one which follows it:
a. All strangers are welcome.
b. No strangers are unwelcome.
c. No unwelcome people are strangers.
d. All strangers are welcome.
e. Some welcome people are strangers.
f. Some strangers are welcome.
g. Some welcome people are not people who are not strangers.
h. Some welcome people are strangers.
i. All welcome people are strangers.
j. Some welcome people are not strangers.
k. Some welcome people are strangers.
l. No welcome person is a stranger.
m. All welcome people are strangers.

3. Do the same with the following:
a. Florida is balmier than Texas.
b. Texas is less balmy than Florida.
c. Texas is neither balmier than Florida, nor equally balmy.
d. Florida is balmier than Texas.
e. Florida is not balmier than Texas.
f. Texas is balmier than Florida, or equally balmy.
g. Texas is not less balmy than Florida.
h. Florida is not less balmy than Texas.

4. And with the following:
a. Some bad boys struck this little fellow.
b. This little fellow was struck by some bad boys.
c. This little fellow was struck by none other than some bad boys.
d. Some bad boys struck this little fellow.
e. Some bad boys did none other than strike this little fellow.
f. No bad boys struck this little fellow.
g. All bad boys struck this little fellow.

5. Put the following in simplest propositional form, then obvert each of them:

a. Only reporters would have such effrontery.
b. All except text-books are barred from this shelf.
c. Unless you take that corridor you will not find him.
d. None but seniors may wear gowns.
e. Catholics alone accept the authority of the pope.

### *Section 7.* TYPES OF RELATION AND TYPES OF SYLLOGISM

The classification of syllogisms

With this practice in the clarification of meanings and in the analysis of implication in its simpler forms behind us, let us approach the syllogism again. And the point which first needs statement is that syllogisms can be best classified and studied in accordance with the kind of relation revealed in their premises. With this in view a thorough analysis of types of implicative relation was not undertaken at the time we were engaged in the classification of terms. Now the two most general ways of classifying relations are in accordance with what I shall call regularity and irregularity, and in accordance with the principles of symmetry and transitiveness.

Differences in the way relations are combined

First, consider two syllogisms representing rather extreme types, and each very different from the other.

Cæsar attacked England.
England was inhabited by the Britons.
∴ Cæsar attacked an island that was inhabited by the Britons.

Mr. W. is the champion golf-player of this state.
Mr. W. is the lawyer whose office is at 24 Elm St.
∴ The champion golf-player of this state is the lawyer whose office is at 24 Elm St.

Let us examine the structure of these syllogisms, with reference to the way in which the relations in the premises are combined in the conclusion. With respect to the first example, it is evident that these relations are combined only in a very external way. The conclusion does not fuse them into a single relation. Another indication of the same fact is that the middle term does not entirely disappear in the conclusion. It still holds the relations apart, though in the form of a more abstract general term—in this case, "island." Now, relations which can

only be combined in inference in this external way let us call *irregular relations*. And we shall find that with the exception of a single type of combination, whenever the relation in one of the premises is irregular, the middle term does not entirely disappear in the conclusion, but remains there holding the relations of the premises apart in the form of a more inclusive general term. By contrast all other relations we shall call *regular relations*.

The relation of identity

The relation involved in the other example is as different in these respects as it could well be. Not only are the relations of the premises fused into a single relation in the conclusion, with the complete disappearance of the middle term, but the relation in the conclusion has exactly the same meaning as the relation in each of the premises. It is, as the reader will note, an instance of what we have called a symmetrical relation, and it has certain logical properties which other symmetrical relations do not have. It is the relation of identity, in that all three of the terms of the syllogism refer to exactly the same individual. What we are saying is, that if a certain individual is identical with the champion golf-player in the state, and is also identical with the lawyer whose office is at 24 Elm St., then the champion golf-player of the state is identical with the lawyer whose office is there located. It is important to distinguish carefully the relation of inclusion from the relation of identity, inasmuch as they are usually expressed by the same form of words. The relation in "This man is a crook" is essentially different from that in "This man is the wiliest crook in town." The former asserts that the subject term is included in a certain class; the latter that the individual referred to by the subject term is identical with the individual referred to by the predicate term.

Intermediate

In respect to the characteristics we have just been examining, the following is clearly intermediate between the two syllogisms considered above:

> Albany is north of New York.
> Boston is east of Albany.
> ∴ Boston is northeast of New York.

Here the middle term disappears in the conclusion entirely, but the relations of the premises differ in meaning, and those differences dictate the character of the single relation in which they are combined in the conclusion. Compare with this in the same respects the following syllogism:

The rafters are ten feet above the floor.
The floor is six feet above the ground.
∴ The rafters are sixteen feet above the ground.

### *Irregular Relations, and Syllogisms in Which They Occur*

Irregular relations

We may begin our analysis of types of syllogism with those in which irregular relations function. This type will not detain us long, for the essential character of such syllogisms is evident from the above discussion. The relation is called irregular because of the fact that it resists real fusion with other relations. Accordingly, the middle term still remains in the conclusion in the form of a more inclusive general term, holding the refractory relations in some kind of order. The question might be raised whether there is any real process of inference in such reasoning. Yet surely the conclusion is made possible only by bringing together the two premises, and its emphasis, at least, is different from that of the premises. The substitution of a more inclusive abstraction for the middle term facilitates a more direct passage of thought between the subject and predicate terms. And whenever this has been brought about there has been inference in the broad sense of the word.

Union of an irregular relation with the relation of identity

There is one exception to the general rule just enunciated about these syllogisms. This appears when an irregular relation in one premise is combined with the relation of identity in the other. In this case the middle term will disappear, and the irregular relation will appear in unchanged form in the conclusion. This follows, of course, from the very meaning of the relation of identity. As an example of this exception:

Henry licked Mickey Walters.
Mickey Walters is the greatest bully in the neighborhood.
∴ Henry licked the greatest bully in the neighborhood.

But in all other cases the general rule holds. The relations unite

only externally, and the middle term persists in attenuated form. Illustrations of the combination of irregular relations with various other types of relation follow:

Bert is engaged to Susan
Susan is less attractive than Ethel.
∴ Bert is engaged to a less attractive girl than Ethel.

Dr. J. shot a grizzly.
Grizzlies are ferocious animals.
∴ Dr. J. shot a ferocious animal.

(The fact that our general principle is present here is obscured by the circumstance that the relation in the second premise is the relation of inclusion. Accordingly, the more inclusive middle term and the predicate term of the conclusion may in such cases coincide.)

The boys built a stone fort.
The stone fort is two feet higher than the fence.
∴ The boys built a structure two feet higher than the fence.

Mr. A. resides in Fort Myers.
Fort Myers is south of Tampa.
∴ Mr. A. resides in a place south of Tampa.

### *Symmetrical and Transitive Relations, and Syllogisms in Which They Occur*

Symmetrical, asymmetrical, and nonsymmetrical relations

We must now come to terms more fully with the method of classifying relations which has become of especial importance in recent logical discussions. This is: into symmetrical, asymmetrical, and nonsymmetrical relations; and into transitive, intransitive, and nontransitive relations.

The term symmetrical we have already used and in a preliminary way defined. A relation is symmetrical when, if A stands in that relation to B, B must also stand in the same relation to A. Constantly recurring examples of such a relationship are found in the relations of identity, equality, distance in space or time, similarity or dissimilarity in some given respect, exclusion, and inclusion if the quantity is particular and vague.

A is identical with B.
∴ B is identical with A.

A is similar in climate to B.
∴ B is similar in climate to A.

A is as pretty as B.
∴ B is as pretty as A.

A is in tune with B.
∴ B is in tune with A.

A is three miles from B.
∴ B is three miles from A.

No A is B.
∴ No B is A.

Some A is B.
∴ Some B is A.

Relations such that, if A stands in the relation to B, B cannot stand in that relation to A, are called asymmetrical. The following exemplify asymmetrical relations:

A is the builder of B.
∴ B is not the builder of A.

A is longer than B.
∴ B is not longer than A.

A is more expensive than B.
∴ B is not more expensive than A.

A is east of B.
∴ B is not east of A.

A is the author of B.
∴ B is not the author of A.

Relations which are ambiguous with respect to symmetry are called nonsymmetrical; that is, they are such that, if A stands in the relation to B, B may or may not stand in the same relation to A. Several common relations are of this ambiguous type. Examples are:

Willie hit Tommy.
(Tommy may have hit Willie, too, but we cannot assume it from the premise.)
The company greeted its visitors.
The children were watching the elephants.
Mr. B. is fond of his wife.
The snake was swallowing its mate.

Transitive relations

The distinction between transitive and intransitive relations is of quite another sort. The two modes of classification cut across each other.

A relation is called transitive when, if A stands in the relation to B, and B in the relation to C, A must stand in the same relation to C. This type of relation is of fundamental importance, for it is central in the thinking of all the exact sciences. It underlies the development of any quantitative series, such as the series built up by the concepts of number, time, space, weight, energy, and the like. No measurement or comparison of anything in respect of quantity is possible without thinking in terms of a transitive relation. Still using our neutral symbols A and B, let us illustrate a few transitive relations.

A is less than B.
B is less than C.
∴ A is less than C.

A is north of B.
B is north of C.
∴ A is north of C.

A is more probable than B.
B is more probable than C.
∴ A is more probable than C.

A happened earlier than B.
B happened earlier than C.
∴ A happened earlier than C.

A is descendant of B.
B is descendant of C.
∴ A is descendant of C.

A is above B.
B is above C.
∴ A is above C.

A is more nervous than B.
B is more nervous than C.
∴ A is more nervous than C.

A is higher in pitch than B.
B is higher in pitch than C.
∴ A is higher in pitch than C.

A is more fragrant than B.
B is more fragrant than C.
∴ A is more fragrant than C.

A is the cause of B (in the broad sense of "cause").
B is the cause of C.
∴ A is the cause of C.

All A is B (universal inclusion).
All B is C.
∴ All A is C.

The list could be expanded almost indefinitely. Every branch of thought in which comparisons are made presupposes a quantitative series, built up in accordance with the principle of transitive relationship. It is interesting to note that many symmetrical relations are also transitive, though some are not.

Line E is the same length as line G.
Line G is the same length as line M.
∴ Line E is the same length as line M.

The relation here is both symmetrical and transitive. The relation of exclusion, on the contrary, while symmetrical, is not transitive.

No smokers are admitted here.
No admittance here to beggars.

**Intransitive and nontransitive relations**

But we cannot conclude that no beggars smoke.

Intransitive relations are such that, if A stands in the relation to B, and B likewise to C, A cannot stand in the same relation to C. The chief examples of such relations are found in series

that are not quantitative, and in those quantitative series where the relation of quantity between the terms is specified in numerical detail.

Wilton is father of Silas.
Silas is father of George.
∴ Wilton is grandfather of George.

$x = 3y.$
$y = 3z.$
$\therefore x = 9z.$

Nontransitive relations are, following the parallel with nonsymmetrical relations, such that, if A stands in the relation to B, and B to C, A may or may not stand in the same relation to C. Some nonsymmetrical relations are also nontransitive, likewise some symmetrical relations are nontransitive, as will be seen from the following illustrations:

John greeted Mary.
Mary greeted Louise.
John may or may not have greeted Louise.

Mr. T. is a friend of Miss X.
Miss X. is a friend of Miss Q.
Mr. T. may or may not be a friend of Miss Q.

I voted for Senator J.
Senator J. voted for Judge S.
I may or may not have voted for Judge S.

Such relations, it will be observed, are usually of the type that we have termed irregular.

EXERCISE.—Characterize the following relations as symmetrical, asymmetrical, or nonsymmetrical; also as transitive, intransitive, or nontransitive:

| | | |
|---|---|---|
| a. Parallel to | b. Inside of | c. Beyond |
| d. Near | e. Next to | f. Was approaching |
| g. Under | h. As blue as | i. Accompanied |
| j. Sweeter than | k. Sister of | l. Married to |
| m. Shot | n. Manufacturer of | o. Searched for |

Syllogisms of symmetrical and transitive relations

Now let us examine the properties of those relations which are both symmetrical and transitive, and of the syllogisms in which they occur. Identity, equality, and similarity in some

defined respect exhibit the more common of these relations. We may list a few important logical characteristics as follows:

1. Where the same symmetrical and transitive relation occurs in both premises, the relation in the conclusion is the same also.

Sam is equal in weight to John.
John is equal in weight to Hilda.
∴ Sam is equal in weight to Hilda.

AB is parallel to CD.
CD is parallel to LM.
∴ AB is parallel to LM.

2. If the symmetrical and transitive relation in one of the premises is the relation of identity, the relation in the conclusion is the same as that of the other premise.

Grand Rapids is north of Indianapolis.
Grand Rapids is the greatest furniture city in the United States.
∴ The greatest furniture city in the United States is north of Indianapolis.

This cloth is the same in color as the contents of that bottle.
The contents of that bottle are an ounce of mercurochrome.
∴ This cloth is the same in color as an ounce of mercurochrome.

3. If the symmetrical and transitive relation in one of the premises asserts similarity in a given respect, and the relation in the other premise is one of difference in the same respect, the relation in the conclusion will be the same as that of the premise which asserts the difference.

$A = B.$
$B > C.$
$\therefore A > C.$

John is less obedient than Alice.
Alice is equal in obedience to Marshall.
∴ John is less obedient than Marshall.

Southern Florida is similar in its flora to Cuba.
Cuba is dissimilar in its flora to Southern California.
∴ Southern Florida is dissimilar in its flora to Southern California.

Miss L.'s voice has a wider range than Miss P.'s.
Miss P.'s voice is equal in range to Miss H.'s.
∴ Miss L.'s voice has a wider range than Miss H.'s.

LM is parallel to PR.
PR is not parallel to TV.
∴ LM is not parallel to TV.

4. Other syllogisms than the above types in which symmetrical and transitive relations occur, can combine the relations in the conclusion only in the external fashion already described in the case of irregular relations.

Caroline is prettier than Marjorie.
Marjorie is a sister of Lorraine.
∴ Caroline is prettier than a sister of Lorraine.

Mr. J. is in love with Miss G.
Miss G. is as wealthy as Miss R.
∴ Mr. J. is in love with as wealthy a girl as Miss R.

It will hardly be profitable to multiply examples here, because the possibilities are endless.

### *Asymmetrical and Transitive Relations, and Syllogisms in Which They Occur*

Importance of asymmetrical and transitive relations

This type of relation is of fundamental importance in the history of thought because it is presupposed in the reasoning of all quantitative science. The fact that the relation involved is transitive enables a series to be generated by its successive repetitions; the fact that it is asymmetrical makes the series irreversible and gives it the peculiar characteristics of infinity. Furthermore, when the most familiar series of this sort, that of number, is applied to other series which have been analyzed into the same type by the discovery and fixation in them of a quantitative unit or standard, exact science becomes possible in the field of facts which are construed in terms of such a series. That is, precise measurement and quantitative comparison in mathematical formulæ may then enter the field, laws stating the behavior of events in it may be put in exact form, and all the

resources developed by mathematical science become available for the deduction of further implications about those events. Since a book on the general principles of right thinking can hardly include an exposition of the entire riches of mathematical science, we shall confine ourselves to the further elucidation of the main points just noted. Detailed study of the various branches of exact science is the only way in which the wealth of implication made possible by asymmetrical and transitive relations can be mastered.

Indefinite quantitative series

The first general consideration to be noted is that such relations may generate a series whose terms, though quantitatively connected, are not given precise numerical ratios. In these cases the conclusion simply asserts the same relation as appears in the premises, no more exact determination in the conclusion being attempted. Such syllogisms are typical of our thinking so far as it essays comparisons in fields which have not been reduced to combinations of equal units, or in circumstances where the need of greater exactitude is not present. The universal proposition affirming the relation of inclusion is a common instance of this sort.

These boys are normal children.
All normal children are active.
∴ These boys are active.

Here no attempt is made to specify the quantitative relations by exact percentages; the reasoning is simply that if group A is included in class B, and class B is included in class C, then group A must be included in class C. Another instance may be taken from the realm of æsthetic appreciation:

The view from the headland is more beautiful than that from the cottage.
The view from the cottage is more beautiful than that from the beach.
∴ The view from the headland is more beautiful than that from the beach.

Until some one succeeds in picking out a definite, invariable unit of beauty that can be applied to the measurement of all beautiful scenes, any such series must be left in this very inexact form, and we may not be able in any objective way to compare

such a series with that in which another type of beauty (for example, architecture) is involved. A very slight further determination is perhaps possible, however—we have the right to insert the adverb "still" in the conclusion: "The view from the headland is still more beautiful than that from the beach." Precisely analogous considerations appear in quantitative series expressing relations of practical value:

> To eat my lunch now is better than to read a few more pages of this book.
> To read a few more pages of this book is better than to tend to my correspondence.
> ∴ To eat my lunch now is better (still) than to tend to my correspondence.

Indefinite series where precision is not needed

In Part IV we shall have occasion to consider more at length the special logical problems involved in attempting to think correctly about fields of this type, in which an exact reduction of the series generated to a combination of definite and equal units seems, as yet at least, to be impossible.

There are cases, also, where asymmetrical and transitive relations which might be expressed in precise form are used indefinitely simply because the circumstances do not demand precision.

> This board is shorter than that.
> That board is shorter than the one by the door.
> ∴ This board is (still) shorter than the one by the door.

Should we need more exact knowledge, and engage, accordingly, in the necessary measurement, this might be replaced by:

> This board is 5/8 of an inch shorter than that.
> That board is 1 1/4 inches shorter than the one by the door.
> ∴ This board is 1 7/8 inches shorter than the one by the door.

The value of precise numerical statement

Now this latter form of the syllogism contains possibilities in comparison with the earlier that are exceedingly important on many accounts. Let us see why. It is clear that as long as our best thinking about most facts is like that represented by the above comparisons of beauty and practical value, our knowledge about the world will be very hazy and choppy, lacking both assurance and unity; consequently, our control over the

natural processes on which we depend for life and happiness is very meager and insecure. It is certain that through the greater part of human history man's reasoning about almost everything that concerns his welfare has been of this vague and scattered type. The series which he was able to develop by the use of asymmetrical and transitive relations were indefinite and lacked inclusion in any more comprehensive system of knowledge. With some apologies to mathematics and astronomy this state of affairs is well illustrated by mediæval science.

But fortunately for the exactitude of much of our contemporary knowledge, and for our control of the conditions of prosperous existence, two events of the greatest significance have occurred in the development of human thinking. One was the discovery of the series of numbers, and the gradual development of symbols adequate to represent the possibilities of the particular asymmetrical and transitive relation by which the number series is generated. In the main, this is the achievement of ancient science, and its substantial beginning occurred so early as to be lost in myth and obscurity. But ancient science never succeeded in applying the number series systematically to other aspects of the world save those revealed in astronomical data and a few mechanical problems. The series of time came to be conceived in mathematical terms, and (with some qualifications) that of points in space, but in other fields of knowledge the quantitative relations were left indefinite and unorganized.

logical nature of number

Let us examine briefly a simple numerical operation in order to see just what number makes possible.

$$A = 3\ B.$$

Here we not only know that A is greater than B, and B greater than C, but we also know in each case exactly how much greater, and this makes it possible to introduce the same kind of precision into the conclusion—we know not merely that A is greater than C, but that it is fifteen times greater. In place of a wholly indefinite quantitative series, making possible only vague comparisons of greater and less, we have an exact series

making possible any degree of exactitude we desire in our comparisons.

How is this remarkable control of our thinking possible? Fundamentally because of the unique characteristics of number. To locate these characteristics we need to grasp clearly such notions as unity, plurality, equality, greater and less, addition, subtraction, multiplication, etc., which in their practical applications all of us master early in life. We come to apprehend how they are used in building up the order of numbers, so that we may apply an infinite system of exact quantitative relationships to any data of our thinking that seem susceptible of such application. To do this, of course, involves an analysis of the facts in question into homogeneous units, of a certain number of which each entity or process may be regarded as composed. In the above case C evidently functions as this unit of analysis. B is reducible to five of C, and since A is likewise reducible to three of B, the entire group of entities become exactly comparable in terms of C units.

The application of mathematics to physical science

The second great event was, accordingly, the appearance of a succession of geniuses, beginning in early modern times, of whom the most outstanding were Galileo, Descartes, and Newton, who dared to conceive the possibility of locating quantitative units in various realms of experienced fact, and of thus applying the number series with all that it makes possible to orders of asymmetrical and transitive relation which had hitherto made available only indefinite comparisons. This involved giving new, exact-mathematical meanings to terms which had before been used in a loose, qualitative sense, such as force; and the clear grasp and fixation in thought of aspects of experienced events in terms of which more phases of their behavior became amenable to mathematical analysis, as in the case of Newton's fixation of the concept of mass. All this brought about, in the early modern period itself, the subjection of the entire field of the motion of bodies to mathematical formulation, and in turn this brought about exact understanding and confident control of certain important aspects of the physical world in terms of

quantitative law. Newton's law of gravitation is the most famous law of this sort.

These successes encouraged other thinkers to make the same attempt in other fields of experience, with the result that methods have been developed of securing at least some application of the number series to the asymmetrical and transitive relations in terms of which all other sciences organize their facts. In the case of the biological, and still more of the social sciences (with the possible exception of economics) this mathematical reduction has so far concerned subordinate problems rather than the basic structure, but in all cases it has meant a gain in exactitude, and it has doubtless paved the way for the fixation of more adequate quantitative units in the future. Thus the history of science since ancient times is fundamentally the history, first, of the establishment of asymmetrical and transitive continuities of the vague and disconnected type, and second, of their gradual transformation, through the discovery in them of characters which make them numerically analyzable, into mathematical continuities. We shall return to this subject by another approach in chapter thirteen, and give extensive illustrations.

The meaning of exact quantitative series revealed in the sciences

It is, therefore, in the concrete results of the various branches of science that we shall find the meaning of specific uses of asymmetrical and transitive relations revealed; and in those that have been systematically reduced to mathematical formulation we discover the concepts in terms of which otherwise indefinite series have been made subject to the implications of number. Only by studying these in detail can we learn how, in reasoning out the bearings of any suggestion involving such concepts, to reach conclusions justified by the meanings of the terms and relations in question. Logic is thus no substitute for concrete scientific knowledge. It may reveal the nature and importance of the general laws of implication; by considering the more important types of relations it can discover the special rules required in dealing with each; but when it comes to questions of further detail, logic must point to the sciences as furnishing, in their established concepts and procedures, the

answers which have so far been reached to them. Is our problem such that a fruitful suggestion involves the conceptions of force, gravity, acceleration, and the like? The way in which the interrelations of these must guide our implicative thinking is revealed in the science of mechanics. Is it such that our reasoning depends on the conception of value (in terms of exchange)? The implications that are possible are studied in the science of economics. Is it such that the conception of reaction-time, or that of intelligence-quotient, is pertinent? Psychology is the science whose business it is to show how implications involving such things can be correctly developed. Of course, in all these studies anyone with a good knowledge of mathematics may reach results that are formally correct, and this illustrates the basic importance for fruitful thinking, in any field permitting exact comparisons, of a good knowledge of mathematics. But apart from specific acquaintance with the specific terms and methods of the various branches of science, the appropriate suggestion could hardly be expected to occur, nor would one understand the bearing of its implications on the problem in hand. One not familiar with the pound sterling as a unit of economic value might infer that a stock selling for sixty pounds was twice as valuable as one selling for thirty, but he would hardly be able to apply the deduction intelligently to its context. Nor would one unacquainted with recent psychological study be greatly benefited by being told that his son's intelligence-quotient is one hundred and fifteen. For these terms, as well as the general principles of reasoning, find their meaning and proper use in the process by which we reason out the implications of specific suggestions in groups of concrete situations. These groups constitute the fields of the various sciences.

**Summary of asymmetrical and transitive relations**

In summary, then, a discussion of the principles of right thinking can only answer in the most general way the question, how to reason correctly in syllogisms built up by the use of asymmetrical and transitive relations. The answer in detail is to be found in the sciences to which mathematical methods have been in whole or in part applied, especially, of course, in pure mathematics itself. The same, to be sure, is true of other types of

syllogism, to the extent that the meaning of the relations used and the way in which they can be correctly combined is to be discovered in whatever branch of knowledge deals in detail with the facts that are most commonly related in our thinking in those ways.

### *Section 8.* THE RELATIONS OF INCLUSION AND EXCLUSION, AND SYLLOGISMS IN WHICH THEY ALONE OCCUR

The relations of inclusion and exclusion in terms of the preceding analysis

The most difficult part of our task in this chapter now faces us. It would be pleasant to stop with the discussion of the three types of syllogism just analyzed, with the various subtypes which it seemed important to note. But the fact remains that much of our ordinary syllogizing is of a sort that does not wholly fit any one of these types. We have used for purposes of illustration certain forms of the relations of inclusion and exclusion, and it has become evident that the relations are rather peculiar from the standpoint of the otherwise exceedingly fruitful analysis in terms of symmetrical and transitive relations and their opposites. The relation of inclusion is asymmetrical and transitive for universal propositions; symmetrical and nontransitive for particular ones. The relation of exclusion (which is the negation of inclusion) is symmetrical and nontransitive for both universal and particular propositions. Yet because of the definite connection between universal and particular, and because inclusion and exclusion are simply negations of each other, it is natural if not inevitable for us to use many syllogisms in which universal and particular, affirmative and negative, are all involved together.

Historical and human significance of these relations

Moreover, it would seem from the history of thought that resort to these relations between classes of objects is one of the earliest ways in which the human mind gets its experience ordered, at least as a preliminary to the discovery of more detailed and exact relations. This is shown by the fact that our definitions spontaneously take the form of including the term defined in a more general term and excluding it from others which are also thus included; we see, too, that ancient logic,

both in Greece and India, attempted to build the entire theory of deduction around these relations, and it is obvious that our contemporary thinking on problems in which quantitative science has so far been of little aid, such as legal, moral, political, and religious problems, tends to fall into syllogisms in which these relations play the central rôle. It is a mark of the passage of a given area of thinking into an exact scientific form that analysis in terms of inclusion and exclusion has been transcended in favor of relations such as we have just been discussing, but if the general assumptions to be presented in Part IV are correct there will always be large realms in which we need to think as clearly as we can, in which this transcendence has not yet been possible. When we attempt to reach conclusions on these questions, still more when the editor, the orator, or the preacher tries to convince us of certain ideas about them, we need to understand clearly in just what ways valid syllogisms can be built up in terms of these relations. Methods of reducing such problems to a form more amenable to quantitative treatment may come in time, but in the meantime we have to make decisions about them as best we can in order to carry on a successful social life. Moreover, it may well be that even when many of our present difficulties are reduced to mathematical analysis, novel problems will have emerged which demand the best solution we can give them before a technique of reducing them has been developed. It is conceivable, perhaps, that sometime we may be able to express and solve in quantitative symbols such questions as whether we ought to work for a democratic or an aristocratic social order, or whether there is or is not a God. But in the meantime we cannot avoid having some opinion on these questions so far as concerns our relevant practical conduct. It is surely desirable that this opinion be as intelligent and consistent as possible even while our thinking lacks the quantitative exactitude of mathematical science. Accordingly, we cannot avoid the responsibility of analyzing the conditions of correct thinking in syllogisms of this kind.

Some of the principles which state these conditions have been noted in passing in our discussion of symmetrical and transitive

relations, and all of them may be easily deduced from the peculiar manner in which exclusion and inclusion of classes may be related in our thinking.

The hypothetical syllogism

Let us examine first a way of formulating these syllogisms (and in a less natural form other syllogisms as well) which is very similar verbally to the way in which our thinking actually proceeds at the fourth step of an act of thought.

> If a man is blind, he needs a guide.
> Mr. H. is blind.
> ∴ He needs a guide.

If this bit of deduction occurred in anybody's actual thinking it probably took this form: If Mr. H. is blind, he needs a guide. The above is one very simple way of revealing the other premise presupposed in the reasoning, and of putting the whole in a form which facilitates testing its validity. It does so while adhering as closely as possible to the natural mode of expression which our thinking at the fourth step tends to take. In fact, the only change is the substitution of a general for a particular subject term in the conditional clause. Accordingly, it may plausibly be surmised that this mode of revealing the major premise implicit in any bit of reasoning was hit upon very early in the history of thinking.

Now a syllogism built up in this way is called a *hypothetical syllogism,* for the major premise consists of a hypothetical proposition. The part introduced by the "if" or some synonym (unless, when, supposing, etc.) is called the *antecedent;* the part which states the consequence of this condition is called the *consequent.*

Rules of validity for hypothetical syllogisms

Now taking such a hypothetical major premise, let us consider the various ways in which the syllogism might be completed.

If a man is blind, he needs a guide.

| | |
|---|---|
| Mr. H. is blind.<br>∴ He needs a guide. | Mr. H. needs a guide.<br>∴ He is blind. |
| Mr. H. is not blind.<br>∴ He does not need a guide. | Mr. H. does not need a guide.<br>∴ He is not blind. |

Which of these are valid? Clearly only the first and last. For

the other two to be valid, the major premise would have to read: If a man needs a guide, he is blind. That is, we should be assuming something quite different from our present major premise, namely that the only possible condition of needing a guide is blindness. But obviously various other antecedents might issue in the same consequent. One might need a guide because he was visiting in a strange city. Accordingly, granted our actual major premise and nothing else, we can only complete a valid syllogism in the two ways:

| | |
|---|---|
| Mr. H. is blind. | Mr. H. does not need a guide. |
| ∴ He needs a guide. | ∴ He is not blind. |

The minor premise of the former *affirms the antecedent* of the major premise, and the conclusion accordingly affirms the consequent. This method of completing a hypothetical syllogism is known technically as the *modus ponens* (ponens = affirming). The minor premise of the latter *denies the consequent* of the major premise. For if the consequent has not followed, obviously neither this nor any other antecedent of it could have been present. Hence the conclusion denies the antecedent. This method is known as the *modus tollens* (tollens = denying). The other two syllogisms, which deny the antecedent or affirm the consequent in the minor premise, are invalid, except in those cases where the antecedent is known to be universally connected with the consequent. In such cases the major premise may be reversed, and accordingly any of the four methods of completing the syllogism is valid. As illustration, examine:

If any substance is water, it is $H_2O$.

But the mere form of a major premise does not indicate that it is legitimate to reverse it, and so without such special knowledge only the methods of affirming the antecedent and denying the consequent are valid.

**The disjunctive syllogism**

Compare with this hypothetical form the following syllogism:

Johnny is either in the nursery or outdoors.
He is not in the nursery.
∴ He is outdoors.

The major premise here is a *disjunctive* proposition—that is, it

specifies two or more possibilities, one of which is asserted to be true of the subject. Now notice that this disjunctive proposition is equivalent to two hypothetical propositions, namely:

> If Johnny is not in the nursery he is outdoors.
> If Johnny is not outdoors he is in the nursery.

Should we add two others, which might occur to the reader's mind?

> If Johnny is in the nursery he is not outdoors.
> If Johnny is outdoors he is not in the nursery.

If these are examined carefully they will be seen to be immediate inferences, and cannot properly serve as major premises of a syllogism. Since we mean by a nursery a room in a house used in a certain way, the terms "nursery" and "outdoors" by their very meanings exclude each other. Thus we have here a type of case which, with the proper addition of the negative, realizes the reversible hypothetical proposition described above. Accordingly, what ways of completing the disjunctive syllogism are valid?

Johnny is either in the nursery or outdoors.

| | |
|---|---|
| He is not in the nursery. | He is not outdoors. |
| ∴ He is outdoors. | ∴ He is in the nursery. |

Suppose we try to complete by affirmative minor premises:

| | |
|---|---|
| He is in the nursery. | He is outdoors. |
| ∴ He is not outdoors. | ∴ He is not in the nursery. |

Do not these minor premises and their conclusions constitute immediate inferences from the meaning of the terms, and render the major premise entirely superfluous? Now if we translate these syllogisms into hypothetical form we shall discover that either of the valid syllogisms can be put into the form of the *modus ponens*, or of the *modus tollens*, as follows:

If Johnny is not in the nursery he is outdoors.

| | |
|---|---|
| He is not in the nursery. | He is not outdoors. |
| (affirms the antecedent) | (denies the consequent) |
| ∴ He is outdoors. | ∴ He is in the nursery. |

If Johnny is not outdoors he is in the nursery.

| | |
|---|---|
| He is not outdoors. | He is not in the nursery. |
| (affirms the antecedent) | (denies the consequent) |
| ∴ He is in the nursery. | ∴ He is outdoors. |

The invalid syllogisms, on the other hand, clearly violate the rules that we have found necessary for hypothetical syllogisms.

However, in reasoning of this sort it is just as simple and natural to leave the major premise in the disjunctive form. We derive thus the rule for valid disjunctive syllogisms: Deny one (or more) of the alternatives in the minor premise, and affirm the other (or others) in the conclusion. The parenthetical phrases are necessary to provide for cases where there are more than two alternatives, as follows:

What I see is either a bush, a dog, or a moss-covered stone.
It is not a bush.
∴ It is either a dog or a moss-covered stone.

Or, It is neither a bush nor a moss-covered stone.
∴ It is a dog.

No new principle appears here, hence further comment is unnecessary.

Further analysis of the invalid cases

But let us examine more fully the reasons why disjunctive syllogisms cannot properly be completed by affirming one of the alternatives in the minor premise, and then denying the other (or others) in the conclusion. In the cases so far cited we have held this to be so because such a minor premise and conclusion constitute an immediate inference, the major premise really playing no rôle at all. We know that "nursery" and "outdoors" mutually exclude each other, hence to say, "He is in the nursery, therefore he is not outdoors," is like saying, "He is in the nursery, therefore he is not out of the nursery." This indicates that we are really dealing with a case of partial obversion. But we do not know that anybody who is not in the nursery must be outdoors, or that anybody who is not outdoors must be in the nursery, hence in the cases we have admitted as valid—where the minor premise is negative—the major premise fills its proper function. Without its specification of the possible alternatives, it would be impossible to draw the conclusion from the minor premise.

Cases of imperfect disjunction

But suppose we are given such a disjunctive proposition as the following:

Mr. X. either committed this crime or derived benefit from it.

No difficulty arises when we complete the syllogism in the ways already recognized as valid.

| | |
|---|---|
| He did not commit it. | He did not derive benefit from it. |
| ∴ He derived benefit from it. | ∴ He committed it. |

If, however, we attempt to make the minor premises affirmative, we discover that the principle applied above fails to hold:

| | |
|---|---|
| He committed it. | He derived benefit from it. |
| ∴ He did not derive benefit from it. | ∴ He did not commit it. |

These are clearly not immediate inferences, and the conclusions may be quite false. For the fact that he committed it would not exclude the possibility of his deriving benefit from it also, nor would the fact that he derived benefit from it exclude the possibility that he committed it. Both alternatives, in other words, might be true of Mr. X. Now this indicates the difficulty of such a syllogism from the logical standpoint. The major premise is not genuinely disjunctive. It is like the classification of a genus into species which overlap one another instead of being mutually exclusive. Accordingly, it is logically defective, and while it is possible without error to complete the syllogism in the ways recognized by the rule, it is doubtful whether, in our actual reasoning, we ever derive any real help from such premises. If it is ever necessary to use such a premise, we may guard against error by adding the third alternative which is really present:

Mr. X. either committed this crime, or derived benefit from it, or *both*.

This addition will not prevent completing the syllogism in the valid manner, for if one of the first two alternatives is negated the third is negated with it. But it will guard against the temptation to assume that if one of the alternatives is true the other must be false. Thus our rule for disjunctive syllogisms is vindicated in two ways. If the major premise is really disjunctive,

the completion of the syllogism by an affirming minor premise constitutes by itself an immediate inference, and the major premise is not functioning in thought at all; if it is not really disjunctive, there is another alternative not explicitly noted (namely, both) and therefore the attempt in the conclusion to negate an alternative on the ground of affirming the other alternative in the minor is fallacious—account is not taken of all the alternatives.

The danger of imperfect disjunctions

These considerations deserve emphasis, for much popular reasoning is based on imperfect disjunctions. It is highly important to avoid being led astray by such reasonings, and to understand the desirability of replacing such defective disjunctions as rapidly as possible by sound ones. Worse still, many of the terms we are condemned to use constantly in our thinking are so vague in meaning that it is hard to tell whether a given pair of them offers a true disjunction or not, and consequently it is easy to assume in one part of our reasoning that they do, and in another part that they do not.

"The fellow who did this must be either a fool or a knave." Is this a genuine disjunction? It is surely difficult to tell with confidence. We may mean by "knave" a sufficiently clever fellow, so that the term "fool" would be manifestly incompatible with it. But we may not. Both terms are pretty loose in their connotation. Hence it is easy to use them in different meanings in different contexts, with resulting inconsecutiveness in our reasoning. Popular language is full of terms revealing the same kind of ambiguity, like good and bad, helpful and harmful, bitter and sweet, and the like. Doubtless we intend them to be mutually exclusive, but yet we find it impossible to maintain them in such a disjunction—we apply them to things which may be good in some respects and bad in others, helpful under certain circumstances and harmful under others, bitter sometimes and sweet at other times. Hence reasonings about them are constantly likely to run astray.

One way to secure good logical discipline in this situation is to make two lists of opposed terms and compare them carefully. Let one list be of pairs that are genuinely contradictory—that

is, definitely exclusive of each other and mutually exhaustive, so that there is no third possibility; the other list being of pairs that are only contrary—that is, generally antithetical in meaning, but not absolutely so, nor excluding other alternatives. The following may serve as the beginning of such an enterprise:

| Contradictories | Contraries |
| --- | --- |
| X—not-X | good—bad |
| mortal—immortal | heavy—light |
| consistent—inconsistent | expensive—cheap |
| living—dead | white—black |
| material—immaterial | beautiful—ugly |
| continuous—discontinuous | generous—stingy |

The dilemma

This leads naturally to an examination of the *dilemma.* The dilemma is a complex form of syllogism, containing both hypothetical and disjunctive propositions. It is essentially a debating or controversial form of reasoning, and is far more often fallacious than sound, either because the disjunction is imperfect or because the premises are not well grounded in fact, or both. Since speakers and writers often seek to convince, or at least to silence us, by fallacious dilemmas, it is important to study their structure and note the conditions of their validity. No new principle is involved in them, but the complex form of the dilemma makes it more difficult to locate errors precisely.

Conditions of its validity

When a dilemma is put in exact syllogistic form, its major premise consists of two hypothetical propositions. The minor premise is a disjunctive proposition, whose alternatives either successively affirm the antecedents of the major (*modus ponens*), or deny the consequents (*modus tollens*). The conclusion then either affirms the consequents or denies the antecedents. It may be a simple categorical assertion or a disjunctive proposition, depending on the nature of the major premise. We shall instance dilemmas in which all these points appear. Consider first the following dilemma:

> If a woman is good-looking, higher education is superfluous; if she is not, it is inadequate.
>
> But a woman is either good-looking or not.
>
> ∴ Higher education for women is either superfluous or inadequate.

This is a case of the *modus ponens,* as the minor premise af-

firms the antecedents of the major, and the conclusion affirms the consequents. Its validity depends largely upon whether "good-looking" and "not good-looking" constitute a genuine disjunction. Of course, over and above the question of validity is the question of the truth of the major premise. What are the assumptions as to the proper destiny of woman which underlie the major premise? Are they justified?

Consider now another dilemma:

> **If God created the world, it would be good, or else there would be some explanation of its badness.**
> **But neither is it good, nor is there any explanation of its badness.**
> **∴ God did not create it.**

Here is an example of the *modus tollens* in a dilemma, since the minor premise denies successively the consequents of the major. But how is it that the conclusion can be expressed in a single clause? The explanation of this is to be found in the fact that the major premise as stated is in a condensed form to avoid repetition. It is really equivalent to: If God created the world it would be good; or if God created it, there would be some explanation of its badness. In other words, the two consequents have the same antecedent. In denying this common antecedent, the conclusion, therefore, takes a simple categorical form. This type of dilemma is often termed *simple* on this account, and is contrasted with the *complex* dilemma whose conclusion must take a disjunctive form. The possibilities of error here are the same as in the case above. Let the reader state them clearly.

**The refutation of a dilemma**

Since dilemmas are more often fallacious than sound, it is often possible to refute them by setting up opposing dilemmas which are just as plausible, but whose conclusions are contradictory. Thus we might reply to the dilemma condemning higher education for women by one in this form:

> **If a woman is good-looking, higher education will increase her charm; if she is not, it will give her an attraction of its own.**
> **But she must be either good-looking or not.**
> **∴ Higher education will either increase her charm or give her an attraction of its own.**

Such a situation indicates that our standard of judgment has shifted in the course of the two syllogisms, and that perhaps neither of our pairs of major assumptions is justified. Accordingly, the opposing dilemmas cancel each other, and neither argument has any value until further evidence is introduced. Such a refutation, however, is a good way of silencing the attempt of an opponent to establish an inadequate dilemma.

In what way is all actual thinking disjunctive?

In dealing with the hypothetical syllogism we discussed briefly its relation to thinking as we actually perform it. What is the relation of the disjunctive syllogism to our actual thinking? If we recall the main points discovered in our analysis of the essential steps of an act of thought, we shall see that the disjunctive syllogism sums up the entire course of our thinking at steps three and four. It expresses in simple form the occurrence of suggested solutions of our problem and the selection of one as a guide to further action in the light of the considerations brought out in their elaboration. Thus the peculiarly mental or inner aspects of our thinking are inherently disjunctive in the manner in which they are naturally performed, and the disjunctive syllogism reveals the conditions of their validity when viewed as an organic whole. The major premise represents the occurrence of suggestions; the minor premise the results of the elaboration of their bearings; the conclusion the selection of one as more suitable than the others.

This may be illustrated by the problem already cited of deciding what means of transportation to use for a trip downtown. The suggested means that occur to me are: the suburban train, the elevated, and the bus. Accordingly, these limit the range of available possibilities, and we proceed in the fourth step on the basis of a disjunctive major premise: My trip will be either by the suburban train, the elevated, or the bus. Now by elaboration of their bearings I proceed to eliminate all but one of these alternatives, the result of this part of my thinking constituting the minor premise. It will not be by the suburban train (for that would involve too long a walk at this end of the trip), nor will it be by the bus (for that would involve a long walk at the other). Therefore it will be by the elevated.

This conclusion expresses the selection of the remaining alternative as a guide to action, since its development shows it to be the most favorable of the three.

Similarly, the third and fourth steps of the scientist's attempt to explain a puzzling fact may be thus summarized. This challenging event must be an instance of A, or of B, or of C. (These are the possibilities to which well-established scientific knowledge seems to limit the case.) Now this consideration shows that it is probably not a case of A. That fact indicates that it can hardly be B. It is therefore likely to be C. He then prepares a positive experiment to test conclusively whether or not it is C. If not, he attempts to enlarge his original disjunction in the light of what the experiment has revealed.

As used in writing or speaking, however, the disjunctive form of presentation is mainly controversial. It is usually possible to show that the major premise does not really include all possible alternatives.

The hypothetical sorites

There is still another type of argument built up by the use of hypothetical propositions. This is termed the *hypothetical sorites* (sorites = chain of reasoning), and is in effect the establishment of a transitive series of conditions and consequents. This is accomplished by making the condition of one consequent the consequent of another, or the consequent of one condition the condition of another, and then in the conclusion dropping out the intermediate terms, just as in the simple transitive argument that A is greater than C because it is greater than B, and B is greater than C. The relation, too, has substantially the same significance as "cause of" in the list on page 186. The following will illustrate the hypothetical sorites:

Unless the kettle boiling be
They labor in vain who make the tea;
Unless the tea be properly made
My guest will not like it, I am afraid;
Unless my guest contented be
She'll never again come visiting me.

Consequently:

Unless the kettle boiling be
She'll never again come visiting me.

EXERCISES.—Characterize the following as hypothetical syllogisms, disjunctive syllogisms, or dilemmas. Put them in exact form for testing. Are they valid? If not, describe technically the ground of invalidity. If they are hypothetical or dilemmas, state whether they instance the *modus ponens* or the *modus tollens*.

1. If the sun shines it will get warm. The sun has just begun to shine. Therefore it will get warm.
2. If he had performed the errand I should not have received this letter. But I have received the letter, therefore he did not perform it.
3. Either I forgot having paid this check, or else it was forged. But it is evidently not forged, hence I must have forgotten paying it.
4. If a man is a Protestant, he believes in the right of private judgment in religion. This man believes in the right of private judgment in religion, hence he must be a Protestant.
5. I recall that Mr. W. is either a Senator or a lawyer. It appears that he is a lawyer. Therefore he is not a Senator.
6. If a body moves, it must either move in the place where it is, or in the place where it is not. It cannot move where it is (for then it would no longer be there), nor can it move where it is not (for it is not there to do it). Therefore a body cannot move. (Argument of the Greek philosopher Zeno).
7. General C. is either in California or Florida. He is in California. Therefore he is not in Florida.
8. That creature is either an owl or a bat. The shape of his wing shows that he is not a bat. Therefore he is an owl.
9. If the clouds do not disappear there will be a beautiful sunset. But they are disappearing. Therefore there will not be a beautiful sunset.
10. Had you taken the right medicine your fever would be gone. It is not gone, so you could not have taken the right medicine.
11. A friend is a dubious blessing. For if he is wealthy he will induce you to make questionable investments, while if he is poor he will borrow money from you.
12. The Greek Sophist Protagoras is reported to have made an agreement with a pupil Euathlus, to teach him the art of pleading at law, on condition that one-half the fee was to be paid when the instruction was completed, the other half when Euathlus had won his first case in court. Euathlus paid the first half, but put off beginning practice. Protagoras finally brought suit for the remainder of the fee, offering this dilemma to justify his position:

    If Euathlus loses this case he must pay me, because that will

be the judgment of the court; if he wins he must pay me as the contract provides.
But he must either lose or win.
Therefore in any case he must pay the fee.
Euathlus countered with the following dilemma:
If I win the case in court, I will not have to pay, for such will be the judge's decision; if I lose it, according to the contract I will not yet have to pay.
But I must win or lose.
Therefore in any case I will not have to pay.

The student should study this pair of dilemmas with especial care, in order to note clearly just where the trouble lies.

13. If the minor premise of a dilemma affirms the antecedents of the major, it is a case of *modus ponens;* if it denies the consequents, it is a case of *modus tollens.*
But the minor premise of a valid dilemma does one or the other of these.
Therefore a valid dilemma is either a case of *modus ponens* or of *modus tollens.*

Bearing of these syllogisms on the relations of inclusion and exclusion

But what bearing has the above analysis on syllogisms involving relations of inclusion and exclusion? The connection appears when we observe that every hypothetical proposition may be put in the form of a categorical proposition affirming one of these relations without change of meaning. A few instances will easily reveal this.

If a man is blind he needs a guide =
All blind men are people who need guides.

If anything is an animal it is mortal=
All animals are mortal.

If you step over this line you are likely to fall =
All who step over this line are likely to fall.

If anyone says that he is a liar =
All who say that are liars.

If anyone commits treason he is no son of mine =
No one who commits treason is a son of mine.

Notice that the resulting categorical statements are all universal in quantity. This is because the meaning of the hypothetical form of statement is that there is a necessary—*i.e.,* universal

connection between condition and consequent. If the reader will try the reverse process he will also find that every universal categorical proposition can likewise easily be put in hypothetical form, as follows:

All bodies gravitate =
If anything is a body, it gravitates.

No president is of foreign birth =
If anyone is president he is not of foreign birth.[1]

This furnishes a method of testing the validity of the latter

Accordingly, it is possible to transfer our rules for validity in the case of hypothetical syllogisms bodily to syllogisms of exclusion and inclusion, and restate them in a form such as will apply them directly to the latter. Or, and some find this procedure just as simple, the major premise of a categorical syllogism can be put in hypothetical form, and the validity then tested by the rules for the hypothetical syllogism. For example, suppose we wish to test the syllogism:

All valid syllogisms have three terms.
This syllogism has three terms.
∴ It is valid.

Putting it in hypothetical form:

If a syllogism is valid it has three terms.
This syllogism has three terms.
It is valid.

We see that the minor premise affirms the consequent, and that therefore the syllogism is invalid. Or take the following:

Students in orientation courses are a selected group.
No upper classmen take orientation courses.
∴ Upper classmen are not a selected group.

Putting it in hypothetical form:

If any students take orientation courses, they constitute a selected group.
Upper classmen do not take orientation courses.
They are not a selected group.

[1] It is at this point that the teacher who desires may helpfully discuss the difference between universal categorical propositions that carry existential import and those that do not. Most teachers will lack the time to develop such a theme in an elementary course, and hence I have excluded such discussions from the text.

Here the minor premise denies the antecedent of the major, and accordingly the reasoning is invalid. But the following are obviously valid, both in their categorical and in their hypothetical form:

| | | |
|---|---|---|
| All B is C | | If anything is B it is C. |
| All A is B | = | A is B |
| ∴ All A is C. | | ∴ A is C. |

| | | |
|---|---|---|
| No L is M. | | If anything is L it is not M |
| All N is L | = | N is L. |
| ∴ No N is M. | | ∴ N is not M, or no N is M. |

**Inadequacy of this method**

However, there is a type of valid categorical syllogism that cannot be translated into hypothetical form; moreover, as noted above, so much of our thinking on matters of common concern, and our attempts to persuade others, or theirs to persuade us, of the soundness of certain convictions, tend to fall so directly into the categorical form when we set forth specifically their assumptions, that it is highly valuable to be able to test combinations of exclusion and inclusion between classes directly, and gain familiarity with separate rules of validity for syllogisms of this type.

**Venn's method of symbolizing inclusion and exclusion**

It will be helpful to approach the deduction of these rules by studying a convenient algebraic and graphical method of representing the type of relation with which we are now concerned. This method in the form here adopted we owe chiefly to the English logician John Venn, and may be found described in the fifth chapter of his *Symbolic Logic*. Its possibility is due to the fact that since in this form of reasoning we are concerned solely with the relations of inclusion and exclusion between classes of objects, the relations can be wholly symbolized by the inclusion or exclusion of areas such as circles or portions of circles. This means that any one of the four possible types of proposition asserting this kind of relationship (universal affirmative or A, particular affirmative or I, universal negative or E, and particular negative or O), can be fully represented graphically, so far as its logical properties go, by a pair of intersecting circles, one stand-

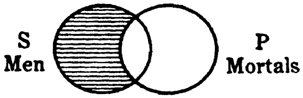
ing for the subject term, the other for the predicate term. Let us consider these four relations in order.

A All S is P All men are mortal.

What is the exact meaning of this proposition? It means that either the class of objects denoted by the predicate term is identical with those denoted by the subject term, or else includes them as a smaller class within it. The statement that all men are mortal illustrates the second of these possibilities; the first is illustrated by such a proposition as: All equilateral triangles are equiangular. How can we express these two possibilities in a single formula? This can be done simply if we put the statement in negative form: There is no S that is not P. To say thus that no member of S is outside of P is to say the same thing as to say that either the two classes are identical or P includes S as a smaller class. Symbolizing not-P by $\bar{P}$, we may express this algebraically as follows:

$$S\bar{P} = 0$$

which is to be read: That which is both S and not-P does not exist. Graphically we represent this relation by shading off that portion of the S circle that is outside P, to indicate that the only S's that can really be found are also in P. The shading thus indicates what area of the intersecting circles is eliminated by the proposition as having no reality.



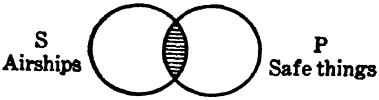

E No S is P No airships are safe.

This proposition means that the objects denoted by subject and predicate terms mutually exclude each other. Accordingly our algebraic representation will be:

$$SP = 0$$

which is to be read: That which is both S and P does not exist. Graphically this is indicated by shading off the intersecting por-

tion of the two circles, showing that this portion has no reality—the only S's that can really be found are outside of P.

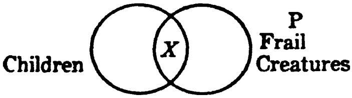



I Some S is P Some children are frail.

This means that some objects are to be found which are both S and P, that is, members of both these classes. Using the mathematical symbol $\neq$ as meaning *is not equal to,* we symbolize this as follows:

$$SP \neq 0$$

which is to be read: That which is both S and P does exist (is not non-existent). Graphically we represent this relation by marking a cross in the intersecting portion of S and P, the cross indicating that this portion is not to be shaded off entirely, there are members to be found there.

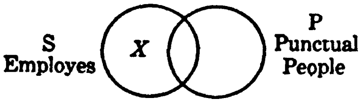



O Some S is not P Some employes are not punctual.

This means that some objects are to be found which are in S but not in P. We symbolize it algebraically by:

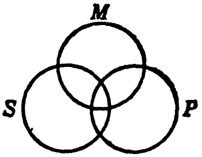
$$S\bar{P} \neq 0$$

which is to be read: That which is both S and not-P does exist. Graphically this relation is represented by marking a cross in the portion of S which is outside of P, to indicate that this portion is not to be shaded off entirely because there are members there.




When a complete syllogism is to be represented by these graphs, each of the three circles must intersect both the others, so that there will be a geometrical area to represent every pos-

sible relation of exclusion or inclusion between the three classes. For purposes of regularity and convenience it is best to let the upper circle stand for the middle term, which is eliminated as we pass to the conclusion. Thus the two lower circles will indicate the relation asserted in the conclusion.




**Value of these symbols in testing validity**

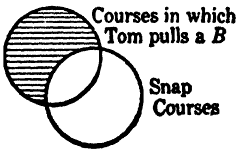
With the aid of these illustrative symbols we are equipped to test the validity of any syllogism using these relations with an ease which is not possible if we try to hold such abstract relations in mind without such support. Our general guiding principle is simple: *If, when symbolizing in a single set of circles the relations affirmed by the premises, we find ourselves forced to symbolize the relation asserted in the conclusion, the syllogism is valid; if the premises permit any other mode of relating the terms than that affirmed in the conclusion, the syllogism is invalid.* The more common ways in which errors may be committed in this process will soon be considered. Let us first symbolize a few syllogisms in order to illustrate the general principle.

1. Professor Z.'s course must be a snap course, because Tom made a B in it.

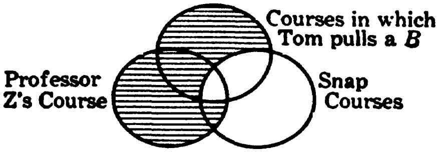
   Stating the assumed major premise and putting the whole in precise form:

   Courses in which Tom makes a B are snap courses. $M\bar{P} = 0$
   Professor Z.'s course is a course in which Tom made a B. $S\bar{M} = 0$
   ∴ Professor Z.'s course must be a snap course. $S\bar{P} = 0$

   The major premise is clearly an A proposition, and accordingly will be symbolized thus:



The minor premise is also an A proposition. Adding the relation there stated, we have:



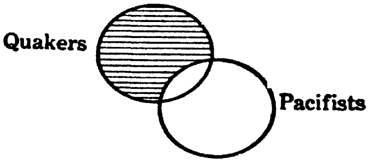

The conclusion asserts that Professor Z.'s course is a snap course, and we find that in symbolizing the relations of the premises we have been forced to symbolize the relation affirmed in the conclusion. For the portion of "Professor Z.'s course" that is outside of "snap courses" has been shaded off and shown to be non-existent. This particular combination of relations, it will be noted, is also a case of asymmetrical and transitive reasoning, and could be demonstrated in terms of their nature; indeed it follows from the still more general principle (of subalternation in immediate inference) that whatever is true of a whole class is true of any part of that class.

2. All Quakers are pacifists. Some of the delegates at this convention, then, must be pacifists.

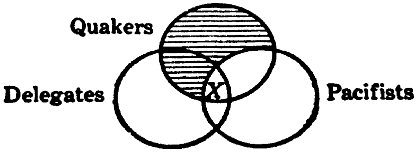
   Putting in precise and complete form:

| | |
|---|---|
| All Quakers are pacifists. | $M\bar{P} = 0$ |
| Some of the delegates at this convention are Quakers. | $SM \neq 0$ |
| ∴ Some of the delegates at this convention are pacifists. | $SP \neq 0$ |

   Symbolizing the major premise:




   Adding the minor premise (an I proposition):



Here again, in symbolizing the assertions of the premises, we have been forced to symbolize the assertion of the conclusion, and the syllogism is therefore valid. The circles represent the assumption of the reasoning that whatever part of a class is included in that which is entirely included in a third class must be itself included in that third class.

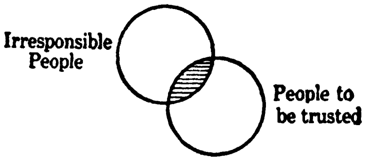
It should be noted that when one premise is particular the other premise must be symbolized first. Otherwise confusion will arise between the shading and the cross. The cross can obviously only be appropriately put in an area which is not eliminated as non-existent.

3. H. is irresponsible, and is therefore not to be trusted.

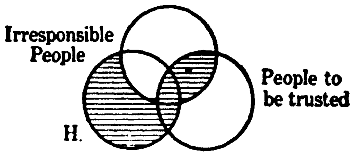
Putting in complete form:

| | |
|---|---|
| No irresponsible person is to be trusted. | $MP = 0$ |
| H. is an irresponsible person. | $S\overline{M} = 0$ |
| ∴ H. is not to be trusted. | $SP = 0$ |

Symbolizing the major premise (E):




Adding the minor premise (A):




Once more the syllogism is valid. Symbolizing the relations in the premises, we find ourselves forced to eliminate the H. inside of "people to be trusted," which is what the conclusion affirms.

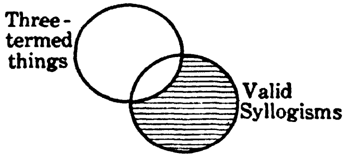
Invalid reasonings symbolized

Let us now test by this method the syllogisms which we recently found to be invalid when translated into hypothetical form.

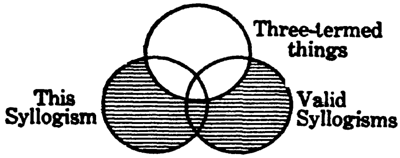
4.

All valid syllogisms have three terms. $P\overline{M} = 0$
This syllogism has three terms. $S\overline{M} = 0$
∴ It is valid.

Symbolizing the major premise:



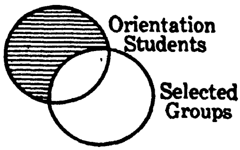

When we add the minor premise, however, all we find that it tells us to do is to eliminate that portion of "this syllogism" which is outside of "three-termed things."



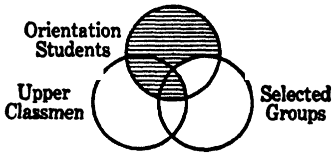

But in order for the conclusion to follow from the premises, we must be forced to eliminate that part of "this syllogism" that is outside the circle of "valid syllogisms." This the premises do not compel us to do, hence the reasoning is shown to be invalid by this method, as well as by translation into the hypothetical form.

5. Students in orientation courses are a selected group.
No upper classmen are students in orientation courses.
∴ Upper classmen are not a selected group.

Symbolizing now the major premise:



Adding the minor premise, we find that no relation either of inclusion or of exclusion is indicated between "upper classmen" and "selected group."




But for the conclusion to follow from the premises the intersecting portion of these two circles would have to have been eliminated. Accordingly the reasoning is shown to be invalid.

**Distributed and undistributed terms**

How can we discover and state in their briefest form the special rules determining validity in syllogisms of this type, to be added in their case to the general rules that apply to all syllogisms? To do this most simply, it is necessary to become acquainted with the notion of *distribution,* as applied to the terms of a proposition. A term is said to be distributed when, as used, it yields information about the entire class of objects which it denotes. It is undistributed if it does not do so. Accordingly, so far as subject terms are concerned, distribution coincides with universality in the quantity of the proposition, while the subject terms of particular propositions are necessarily undistributed.

With predicate terms the matter is more complex, but our study of the process of conversion gives us some help. Since the E and the I propositions can be converted directly, the predicate terms must be like the subject terms in this respect —that of the E proposition must be distributed, that of the I undistributed. Since the A proposition can only be converted by limitation, losing its universality in the process, its predicate term must be undistributed; we are given no information about all the objects which it names. In the case of the O proposition the predicate term is distributed. For although we cannot convert it except by using a highly artificial form of statement,

the predicate term is clearly meant to apply universally. Our method of shading the circles shows this. "Some A is not B" means that some A is outside of all the objects denoted by B. And if we do convert the proposition we must find some form of words that will state this fact: All B excludes some A.

We may summarize the matter then by saying that in the case of universal propositions the subject terms are distributed, in the case of particular ones they are undistributed; while with affirmative propositions the predicate terms are undistributed, with negative propositions they are distributed. The following table will help:

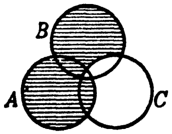
A proposition—subject distributed, predicate undistributed.
E proposition—subject distributed, predicate distributed.
I proposition—subject undistributed, predicate undistributed.
O proposition—subject undistributed, predicate distributed.

**Deduction of the valid combinations of premises**

Now let us discover the rules, using the above method of circles to aid in demonstrating them. Since the combinations of these possible types of proposition in any pair of premises are not many, we may do this by examining the combinations exhaustively, and noting what common features the invalid combinations possess and why they must produce invalidity. In order to concentrate attention purely on the combination of relations, let us use the neutral symbols A, B, and C for the three terms. What combinations yield valid conclusions?

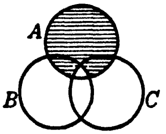
1. When the premises are both A propositions.

All A is B.
All B is C.



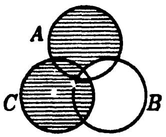

∴ All A is C.

All A is B.
All A is C.



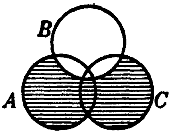

No conclusion.[1]

All A is B.
All C is A.




∴ All C is B.

All A is B.
All C is B.

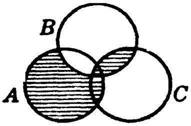



No conclusion.

[1] This would permit a particular conclusion if we could be sure that there actually are members of the classes. But we are not sure, and one value of the Venn diagrams is that it distinguishes between areas that are not eliminated and those that are positively occupied.

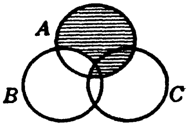
2. When one premise is A, one E.

All A is B.
No B is C, or,
no C is B.




∴ No A is C.

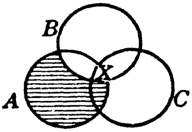
All A is B.
No A is C, or,
no C is A.




No conclusion.

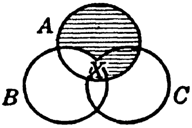
3. When one premise is A, one I.

All A is B.
Some B is C, or,
some C is B.




No conclusion.[1]

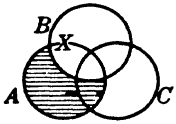
All A is B.
Some A is C, or,
some C is A.




∴ Some B is C.

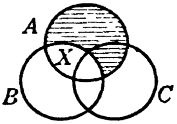
4. When one premise is A, one O.

All A is B.
Some B is not C.



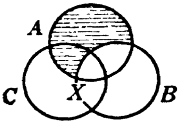

No conclusion.

All A is B.
Some A is not C.



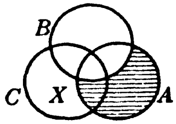

∴ Some B is not C.

All A is B.
Some C is not A.




No conclusion.

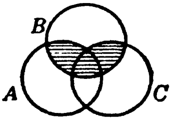
All A is B.
Some C is not B.




∴ Some C is not A.

5. When both premises are E propositions.

No A is B, or, no B is A. No B is C, or, no C is B.

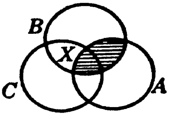



No conclusion.

[1] Note that the X should be placed on the line separating two areas when either area is consistent with the premises. Otherwise an unwarranted conclusion might be indicated.

6. When one premise is E, one I.

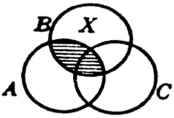
No A is B, or, no B is A.
Some B is C, or, some C is B.




∴ Some C is not A.

7. When one premise is E, one O.

No A is B, or, no B is A.
Some B is not C.

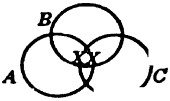



No conclusion.

Let the student show that when the minor premise is: Some C is not B, there is likewise no conclusion.

8. When both premises are I propositions.

Some A is B, or, some B is A.
Some B is C, or, some C is B.




No conclusion.

Most A is B.
Most A is C.
∴ Some C is B.
∴ Some B is C.

This may best be shown algebraically. Circles will not do.

$\frac{A}{2}+\frac{A}{x}$ is B.

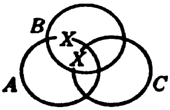
$\frac{A}{2}+\frac{A}{x}$ is C.

X is a positive integer higher than 2.

Hence at least the smaller $\frac{A}{x}$ is common to B and C.

9. When one premise is I, one O.

Some A is B.
Some B is not C.




No conclusion.

Most A is B.
Most A is not C.
∴ Some B is not C.

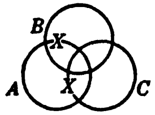
$\frac{A}{2}+\frac{A}{x}$ is B.

$\frac{A}{2}+\frac{A}{x}$ is not C.

Hence at least the smaller $\frac{A}{x}$ is B but not C.

10. When both premises are O propositions.

Some A is not B.
Some B is not C.




No conclusion.

Deduction from these combinations

If now, we examine the invalid combinations in the light of the ambiguity shown by their circular representations, we may quickly formulate the rules for validity in this type of syllogism and see the reasons for them.

Notice first that no combination of negative premises yields any conclusion, and the reason is evident. The fact that two classes are each excluded from a third can indicate nothing as to the relation between themselves, for there is no positive basis of comparing them. Similarly, if one premise is negative, the conclusion must be negative. For the fact that one class is excluded from another cannot prove its inclusion in a third, however the latter be related to the one excluded from it.

Exactly the same points apply to particular affirmative propositions in relation to universal ones, with a single exception. Two particular premises can yield no conclusion, for the fact that one class is partially included in two others cannot prove that those parts have any objects in common. And if one premise is particular the conclusion must be particular, since the fact that one class is partially included in another can never indicate its complete inclusion in a third.

The exception is the case where more than half the class denoted by the middle term is explicitly referred to in both premises. This evidently gives some positive basis of comparison of the other two classes, and a particular conclusion relating them is possible.

But now if we study this necessity with reference to particular propositions in the light of the notion of distribution we shall

discover a clue to the other invalid combinations. Notice that if both premises are particular the middle term is not distributed in either of them. But if not, the members of the class referred to in one premise may be entirely different from those referred to by the same term in the other premise. When this is the case the middle term gives no positive basis of comparing the other terms. We see hence that it is necessary for the middle term to be distributed at least once in order that the class to which it refers may become a definite basis of comparison. In the light of this discovery let us examine the last of the four combinations under (1) and the first under (3) and (4). Here too the middle term is undistributed in both premises, and it is evident why no conclusion can be drawn from them.

Notice in the same way what we should be doing if we affirmed a universal conclusion when one of the premises were particular. The subject term would be distributed in the conclusion when it was undistributed in its premise, that is, we should be affirming something in the conclusion about an entire class when the premises only gave information about a part of it. Obviously this would be illegitimate. But let us look at the invalid combinations that still remain. Suppose we try to draw a conclusion from them, obeying the rules so far seen to be necessary. We find that either the subject or the predicate term would have to be used distributively in the conclusion when it had been undistributed in its premise. The reason for our inability to draw a conclusion is hence evident.

**Formulation of the rules**

The combinations that avoid these errors are all valid, and we see that by avoiding them the essential nature of the relations of inclusion and of exclusion is fully respected. We may, then, formulate the special rules for syllogisms of this sort as follows:

(1) Negative premises yield no conclusion, and if one premise is negative the conclusion must be negative. The violation of the first part of this rule constitutes the fallacy of *negative premises;* of the second part, the fallacy of an *affirmative conclusion from a negative premise.*

(2) The terms must be so distributed that we do not

assume information about the whole of a class when the material given only yields information about a part of it. This rule subdivides as follows:

(a) The middle term must be distributed in at least one of the premises.

This includes the fact that particular premises yield no conclusion, save where the quantity of the middle term in both premises is definitely asserted to be more than half. The violation of this rule is technically termed *undistributed middle*.

(b) No term may be distributed in the conclusion if it is undistributed in its premise.

This includes the fact that if one premise is particular the conclusion must be particular. The violation of this rule in the case of the subject or minor term is called *illicit minor*, in the case of the predicate or major *illicit major*.

We have, then, these special rules for syllogisms, using relations of inclusion and exclusion only, besides the general rules that apply to all syllogisms.

braic symbolization of the valid combinations

A word may be added for those interested in the algebraic symbolization of these relations as an indication of the method and possibilities developed in symbolic logic. Just what is assumed in the valid combinations of premises?

When both are universal either both are A propositions or one is A and one E. In the former event the middle term must be once subject and once predicate, in the latter event it must be the predicate of the A proposition, or the rule regarding distribution will be violated. We represent the reasoning algebraically then either by:

| | | | | |
|---|---|---|---|---|
| $A\bar{B} = 0$ | All A is B | | $A\bar{B} = 0$ | All A is B |
| $B\bar{C} = 0$ | All B is C | or by: | $BC = 0$ | No B is C |
| $\therefore A\bar{C} = 0$ | ∴ All A is C | | $\therefore AC = 0$ | ∴ No A is C |

What is the common postulate in these two processes? Clearly the following:

$$Z = 0,) > (YZ = 0).$$

If neither that which is both X and Y nor that which is both non-X and Z exists, then that which is both Y and Z does not exist. (Notice that the sign of addition means: that which is either. . . . or . . . ; the sign of multiplication, that which is both . . . and . . . ; the sign $>$, implies that. . . .).

When one premise is particular the procedure is somewhat different. The special postulate introduced is as follows:

$$X = XY + X\overline{Y}.$$

X equals that which is either X and Y or X and not-Y. (The validity of this will be realized if we turn from the symbols to a concrete case—the class of men is equal to the class of those that are either white men or men that are not white.)

Let us see how this postulate is used in syllogisms containing particular premises. Suppose we have the premises:

| | |
|---|---|
| No A is B | $AB = 0$ |
| Some C is A | $CA \neq 0$ |

According to the above postulate

$CA = CAB + CA\overline{B}$

Hence $CAB + CA\overline{B} \neq 0$

But $CAB = 0$, since $AB = 0$. (If dragons do not exist, ferocious dragons can hardly exist.)

Therefore $CA\overline{B} \neq 0$, and

Finally, $C\overline{B} \neq 0$. (If there are white rats in existence, there must be rats in existence.)

That is, some C is not B.[1]

EXERCISES.—Put the following syllogisms in correct form for testing, tell whether they are valid or not, and if there is a fallacy, state which rule is violated:

1. No sensible man despises friendships. He is a sensible man; therefore he does not despise friendships.
2. All human productions are liable to change. Scientific theories are human productions, and so are liable to change.
3. A good conscience is not wealth, but a good conscience satisfies. Hence wealth does not satisfy.
4. Planets move round the sun. The earth moves round the sun, and therefore must be a planet.
5. Power is desired by all men. Now money is power, and hence it must be desired by all men.

[1] The teacher who desires will find this a good point at which to explain the principle of Mrs. Ladd-Franklin's inconsistent triad.

6. The fearful are not happy. Greedy men are fearful, and therefore are not happy.
7. Language is the communication of information by signs, hence the bristling of a cat's fur is language.
8. Edith is terribly old-fashioned. She hasn't even bobbed her hair yet.
9. Habitual smokers are not long-lived. But you will enjoy a ripe old age, for you have avoided the weed.
10. Florence is trying to raise her mark. I see her frequently asking questions after class.
11. We love God because He first loved us.
12. People who spread malicious gossip are liars, and you spread malicious gossip about me.
13. God's in His heaven; all's right with the world.
14. Most of the students in this class are seniors. Sixty per cent of the class received B or above, hence the grade of some seniors was B or above.
15. All missionaries are morally reputable. Among the visitors at this resort are missionaries, hence the visitors here must be morally reputable.
16. Those who know their subject pass examinations, and it is among those who attack an examination confidently that you will find those who know their subject. Hence those who attack an examination confidently will not fail.
17. No student presented a class card, but all the students were admitted. Hence none who were admitted had class cards.
18. Only upper classmen are eligible. These boys have been pronounced ineligible, hence they must be freshmen.
19. All trespassers will be prosecuted. I shall carefully avoid trespass, and hence need not fear prosecution.
20. Let us eat, drink, and be merry, for tomorrow we die.
21. Most freshmen are promoted. Most students whose grades are unsatisfactory are freshmen, hence some students whose grades are unsatisfactory must be promoted.

## *Section 9.* FALLACIES

**What is a fallacy?** *Fallacy* is the technical logical description of any form of invalid deduction, that is, any case in which one assertion purports to be deduced from another or others, but in which the premises do not, in fact, yield the proffered conclusion. Accordingly, if our rules for validity in the case of the various distinguished types of syllogism are correct and inclusive, every

violation of these rules will constitute one form of fallacy. Most of these possible fallacies have been noted in connection with the rules; we shall here simply summarize a few important points about them in the light of the analysis as a whole.

Two general types of fallacy

Our study of the essential nature of the syllogism yields two general rules for validity. Since, on the one hand, every syllogism contains three propositions, in which each of the terms is used twice, the middle term in the two premises and the other terms in the conclusion and one of the premises, *the first fundamental rule is that there must be only three terms, and that these terms must be used throughout in the same sense.* On the other hand, since the relation in the conclusion is the logical product of the relations in the premises, *the second fundamental rule is that this combination in the conclusion of the relations of the premises shall be performed correctly in accordance with their meaning.* The two general types of fallacy, therefore, are: first, the fallacy of *four terms* (given this name because of the fact that most syllogisms contain only three terms); and, second, the fallacy of a *third relation,* which consists in substituting, in the conclusion, a different relation $R_3$ for the required combination $(R_1R_2)$. The former of these is violated either when there is no middle term or when there is a term in the conclusion not contained in the premises, or, likewise, when any of the terms shifts its meaning in the course of the argument. Let us examine in turn these two general types of fallacy.

The fallacy of four terms

The following is obviously a case of the fallacy of four terms: "George Washington told us to avoid entangling alliances; we certainly ought not, then, join the League of Nations." About the best that we can do with this by way of putting it into precise syllogistic form is as follows:

> Entangling alliances are things George Washington told us to avoid.
> The League of Nations is an entangling alliance.
> ∴ The League of Nations is something we ought not to join.

By converting the premise and the conclusion we can with this material construct a syllogism whose middle and minor terms conform to the rule, but whose major term in the conclusion

is very different from the corresponding term in the major premise. Hence in order to deduce such a conclusion we need another premise not given, namely, "We ought to do nothing that George Washington told us to avoid."

But compare with the above the following syllogism:

> **Whoever obeys laws submits himself to a governing will.**
> **Nature obeys laws.**
> **∴ Nature submits herself to a governing will.**

Here we have what appears to be a valid syllogism, consisting of three universal affirmative propositions in the form: All B is C, All A is B, All A is C. But it is necessary to scrutinize carefully to see whether any of the terms, though verbally unchanged, may not shift in meaning somewhat in the course of the argument. There is ground for suspecting this in the case of the phrase "obeys laws." In the major premise the phrase refers to the situation of a free moral being in relation to a political superior. In the minor premise the phrase is perhaps used only metaphorically, for the laws of nature from the standpoint of science are simply generalized descriptions of behavior. They describe rather than prescribe, and if they are correctly stated they cannot be broken. Where such differences of meaning obtain, the fallacy of four terms is present even if verbally there are only three terms in the syllogism.

**These mistakes due to vagueness of terms**

Why should anyone make such mistakes as these? So far as the second case is concerned, the answer might be found simply in the vagueness or variability of meaning of many of the common terms which we have to use in our reasoning. The only way to overcome the tendency to commit such fallacies is to form the habit of examining terms with care in order to detect variations in their meaning and discover whether there is such a variation in the deduction in question. The student will find the following syllogism an interesting study for this purpose:

> **Who calls you a man speaks truly.**
> **Who calls you a fool calls you a man.**
> **∴ Who calls you a fool speaks truly.**

So far as the first case is concerned, we are brought back

to some of the illogical tendencies of human nature discussed in chapter three. To some extent the problem involves considerations which properly belong in Part III, namely the question whether our premises have been verified and are therefore legitimately assumed or not. Here our investigation is of validity simply; we accept the premises without question, and inquire what follows from them. Still, we cannot avoid examining, even here, the question why anybody should ever be deceived by an argument which, when put in precise form, contains a term in the conclusion which is not in the avowed premises at all. In most cases of this sort the question will be found answerable in the following manner.

**Or to irrational psychological factors**

Anyone who propounds for the acceptance of others such an argument as that of George Washington and the League of Nations almost surely did not, when in his own thinking he reached the conclusion that we ought not to join it, arrive there by way of the premises he now proffers. He accepted the conclusion by the route of emotion rather than by that of clear ideas. He vaguely feared complications with foreign nations, disliked the thought of abandoning the traditional isolation of America, distrusted novel steps of importance anyhow. Under the play of these emotional forces he feels, rather than rationally concludes, that we ought not to join the League. But obviously these emotional factors cannot be used as logical premises to justify the conclusion, either to himself or to other people whom he seeks to persuade of the same conviction. Accordingly, having adopted the conclusion already, the problem of his real thinking is to find socially acceptable premises to justify it to himself and others. He engages in a type of thinking which in chapter three was described as *rationalization*—that is, the search for good reasons to support a conclusion that he has been moved to accept by causes mainly illogical. He turns then to the premise "George Washington told us to avoid entangling alliances." Logically, as we have seen, this reasoning needs another premise in order that the conclusion may be really deduced, namely, "Whatever George Washington told

us to do we ought to do." Neither he nor anybody else would be likely to believe this premise unequivocally if it were openly stated, hence it remains unstated, but operates in a vague emotional way to make the conclusion seem plausible. As its author then states the argument, natural emotional forces operate to ease the way of the minds of his hearers from the premise to the conclusion, so that they may accept it as valid without seeing clearly the hidden premise which is really involved. In this case the forces thus operating are our general feeling of reverence for the great men of the past, and the particular feeling of loyalty to the father of our country. Under the sway of these feelings our minds are easily and smoothly led from the thought of George Washington's warning to the thought "avoid the League of Nations" without our realizing clearly the fact that we are assuming a premise which if stated we should not at all grant without reservations.

Man emotional as well as rational

The fundamental fact underlying such illogicality is that man is a creature of emotion as well as of reason. There are various ways of playing upon the emotions of people in order to cover up inadequacies of logic, ways which can be distinguished in detail by noting the most common modes of emotional attachment characteristic of human nature.

Playing upon reverence for the past, just exemplified, or upon accepted authority, is one of these; others are revealed in playing upon prevalent superstitions, upon sympathy for the unfortunate, upon ignorance, upon fear of evil consequences from the rejection of a traditional belief, or upon known specific biases of the individual or group immediately addressed. The scholastic logicians, in their meticulous way, gave technical names to each of these illogical processes: *argumentum ad verecundiam, argumentum ad populum, argumentum ad misericordiam, argumentum ad ignorantiam, argumentum ad baculum,* and *argumentum ad hominem.* The list could, if desired, be expanded considerably by the aid of modern psychological analysis.

In the above illustration, and usually, this play upon emotion to cover up weaknesses of logic, results in what traditional

*Non sequitur* and irrelevant conclusion

logic termed a *non sequitur*—that is, a case in which the conclusion does not really follow from the premises by which it purports to be supported. If the conclusion proved is different from that demanded by the argument, but is one which the author hopes will be accepted as its equivalent by his readers or hearers, we have a case of *irrelevant conclusion.* Emotional factors are counted upon to hide the real and perhaps otherwise obvious difference between them.

Begging the question

Sometimes, however, this camouflage of illogicality by emotional appeal takes a form sufficiently different to command a different description, that of *petitio principii,* or begging the question. This is revealed in two ways. One is to assume what is substantially identical with the conclusion in one or both of the premises, thus making the argument a matter of words merely, with no real reasoning involved. The following may illustrate this way of begging the question:

The salvation of the soul is the supreme consideration.
The supreme consideration is what is of greatest moment in life.
∴ The salvation of the soul is what is of greatest moment in life.

Here the minor premise is hardly more than a *tautology*—that is, the ideas of subject and predicate differ verbally only. Hence there is hardly any real reasoning involved; the conclusion is the same as the major premise essentially. The only case of reasoning in which tautologies play a legitimate function is where they constitute a logical definition, or an illuminating identification. The other, and more common, way of begging the question, is to construct a series of two or more syllogisms, the major premise of the first having about the same meaning as the conclusion of the last. This type of argument is called *reasoning in a circle.* When other matter, descriptive or hortatory, is injected between the segments of the circle, and the conclusion is one supported by emotional considerations, this quite irrational procedure is apt to deceive many people. The following case may suffice:

Whatever the Bible says is true.
The Bible says there is a God.
∴ That there is a God is true.

Whatever God reveals is true.
The Bible is God's revelation.
∴ The Bible is true.

Poetic rationalization

We may note in passing that there is a kind of rationalization which does not exactly conform to any of the above types. Let us venture to call it poetic rationalization, since it is not meant to deceive anybody, and probably does not do so. It shows how our habit of argumentation and of rationalization naturally spreads out over conscious processes to which it is inappropriate, and consists in giving what seems verbally a logical reason for a proposition that is frankly and obviously the expression of an emotional preference. Take the case:

I love little pussy, her coat is so warm.

Apparently, to some extent, at least, the second clause purports to operate as a premise from which the first clause is deduced as a conclusion. But if we take the sentence as being really a case of logical inference, we are implying the following major premise: "Creatures with warm coats are creatures I love." Obviously this is not intended. The statement is simply a case of frank emotional preference masquerading in logical form. It parades some character of the preferred object that is specifically satisfying as though it were a reason for the preference. Analyze in the light of these suggestions the real nature of the following declaration of an impassioned lover:

I adore you because you're you.

The fallacies of division and of composition

We approach now a group of four-term fallacies which fall somewhat between the two types that have just been examined. They are not cases of the same word used in different senses, nor do they substitute an entirely new term in the conclusion or imply an impossible major premise after the fashion of the above camouflaged plays upon emotion. Yet there is a partial substitution of meanings which is logically illegitimate. This group comprises the errors in reasoning which have been traditionally termed the *fallacy of division* and the *fallacy of composition.* Let us describe and exemplify each of these briefly.

The fallacy of division consists in substituting for a term denoting a collection or group, during a piece of reasoning, a term denoting only a part or member of the collection. It thus assumes that what is true of the collection taken as a whole is true of each part or member taken by itself.

Division illustrated

> Fraternities do not maintain a high scholastic standard.
> This boy is a fraternity member.
> ∴ He does not maintain a high scholastic standard.

Clearly, it might be true that the average grade of fraternities is lower than that of other groups of students without the consequence that the grade of every individual fraternity member must be low.

The fallacy of composition is the reverse of the fallacy of division. It assumes that what is true of individuals taken singly will hold true of the groups which they may form taken as groups. A classic instance of this is John Stuart Mill's attempt to demonstrate from psychological assumptions the Utilitarian principle of the greatest good of the greatest number. Mill implies first these premises:

Composition illustrated

> The good is what is desired.
> Each person desires his own happiness.

He then proceeds:

> This, however, being a fact, we have not only all the proof which the case admits of, but all which it is possible to require, that happiness is a good, that each person's happiness is a good to that person, and the general happiness, therefore, a good to the aggregate of all persons.[1]

Essentially the same kind of error is revealed in reasoning that because something has a certain property in small quantities it will have more of that property in larger quantities. As if some one were to conclude that since a tablespoonful of a certain medicine is beneficial, a cup of it will be still more salutary!

The fallacy of accident and the converse fallacy of accident, so-called, used to be distinguished from the fallacies of division and of composition, though treated in the same manner. The

The so-called fallacy of accident and its converse

[1] *Utilitarianism*, ch. 4.

former consists in assuming that what is true of a thing generally is true under unusual circumstances; the latter that what is true under unusual circumstances is true generally. But, as will be shown in a later chapter, these are really inductive rather than deductive fallacies. The one depends on failure to recognize that exceptions may be discovered to any established law; the other on the tendency to hasty generalization—that is, the assumption of a general law on experience of too few instances. Such errors reveal strong irrationalities in human nature, but inasmuch as the implied major premise is really accepted in each case and there is no definite shift of terms, the mistakes are hardly cases of invalid reasoning, strictly.

The student will observe that the fallacies of undistributed middle and of illicit major and minor are forms of the fallacy of four terms in syllogisms of inclusion and exclusion. The extension of these terms referred to in one part of the syllogism may be different from that referred to in another.

Summary of fallacies of four terms

So much for fallacies concerning chiefly the terms in a syllogism. We see that they are all reducible to some form of the fallacy of four terms, and are due either to inadvertence in dealing with terms of variable meaning, to the influence of strong emotional tendencies smoothing the substitution of one term for another, or to carelessness in distinguishing the character of wholes as wholes from that of their parts as parts. The remedy is, of course, systematic analysis and practice in dissecting four-term fallacies of these various types, so that we may be on better guard against deception by them both in our own rationalizing and in the reasonings of others. We come now to the fallacies connected chiefly with relations.

The fallacy of a third relation

These will be discussed much more summarily. Except for syllogisms which use only the relations of inclusion and exclusion, we do not often make mistakes in the proper combining of relations, so long as the terms are held without variation of meaning and some familiarity has been gained with the properties of the relations involved. In the case of the commonly used relations these properties are simple and definite, and so many of them, as in scientific thinking, can be fixed by the

use of neutral symbols ( $=$, $>$, $\neq$, :, $\frac{1}{2}$, $\sqrt{\ }$, etc.), that once we have grasped their meaning, the errors that we fall into in manipulating them are almost always errors of inattention merely, or of inability to hold together in consciousness a train of deductive thinking involving several different steps or processes. They are of the sort that anyone might commit in adding a long column of figures, or in solving a complicated algebraic problem containing several unknown quantities. We have already noted that mastery of such relations is, in detail, the task of the various sciences. And it is largely because they are there represented by symbols whose exact meaning we may quickly become familiar with, and whose dispassionate form arouses no emotions of reverence, pity, fear, and the like, that in dealing with them we are not in serious danger of smoothing over logical fallacies by playing upon the feelings of ourselves or others. That "figures never lie," however attacked, is a sound principle, if it is taken to mean what it ought to mean, namely that given correct figures in our premises, the demonstrations from them will also be correct provided that we understand the mathematical processes involved and do not allow our concentration to wander by the way. Accordingly, further discussion of fallacies involving combinations of these relations may be omitted here.

**Contribution of the science of symbolic logic**

The student will observe that the fallacies concerning negative premises as occurring in syllogisms of inclusion and exclusion are improper combinations of the relations of the premises. The modern science of symbolic logic has, as the last section shows, reduced relations of this type to symbolic form, constructing a system which reveals the same rigor and simplicity as a mathematical discipline. In our ordinary thinking, however, about social, religious, and legal problems, which is usually reducible in its implicative phase to such syllogisms, we have not yet put this symbolic form to any systematic use. The chief reason for this is that our main difficulty in such reasonings is to determine exactly what our terms and propositions mean in relation to each other, and to arrange them in precise form for testing. This preliminary determination and arrangement has to be done in

any event before the problem can be translated into the appropriate symbols. But once the meanings are clear and the argument properly arranged, the combining of the relations presents little difficulty; we can usually tell at once, by the aid of the rules for such syllogisms, whether the reasoning is valid or not, without bothering to translate the material thus untangled into symbolic form. Occasionally, of course, complicated situations arise in which such translation proves of real service, as, for example, the application to a concrete case of several regulations of a club, a university, or a political constitution. Professor Venn discusses such possibilities illuminatingly in the thirteenth chapter of his *Symbolic Logic*. But it is only in rare and complex cases that this is true.

**How to reduce arguments to syllogistic form**

It will be valuable to interject here a few suggestions that may be of aid to the student in reducing a baffling piece of argumentative material to proper form for testing. The best general method of attack is to disentangle the conclusion first and express it correctly as a logical proposition. Then work back from it to the premises, always being carefully faithful to the material actually given so as not to make valid a case of invalid reasoning by inventing a premise different from the one which seems to be actually present in the thinking. Remember that in the most common form of syllogisms of inclusion and exclusion the subject of the minor premise will be the same as the subject of the conclusion, and the predicate of the major premise the same as the predicate of the conclusion, the middle term functioning as subject of the major premise and predicate of the minor. Indeed, all valid syllogisms of this type can be arranged in such a manner if we desire.

Let us consider an illustration of this method of procedure. We are given the deduction: "Educated among savages, he could not be expected to know the customs of polite society." On inspection we observe that the first clause is meant to give a reason for the second. The latter may therefore be set up as the conclusion.

**He is one who could not be expected to know the customs of polite society.**

We now have our major and minor terms, and may place them in their anticipated positions:

ones who could not be expected to know the customs of polite society.

He

∴ He is one who could not be expected to know the customs of polite society.

What, now, is the middle term? Obviously the one idea in the given material that we have not yet dealt with—"educated among savages." We may then insert this in the places ready for the middle term, and the syllogism is complete.

Those educated among savages are people who could not be expected to know the customs of polite society.
He is educated among savages.
∴ He is one who could not be expected to know the customs of polite society.

It is well to practice with material of gradually increasing difficulty, containing more and more lengthy or superfluous phrases, etc., till one is able to handle readily any argument reducible to a single syllogism. Then the same method of practice should be followed in analyzing and reducing material which can only be correctly handled in more than one syllogism.

**The fallacy of accent and amphiboly**

Two other forms of misinterpretation of meaning that may lead to invalid reasoning should be noted at this point. One is due simply to accent. Read, for example, the prohibition "Thou shalt not bear false witness against thy neighbor," accentuating the last word, and the commandment may carry an unintended implication. This has been sometimes called the *fallacy of accent.* The other results from an ambiguous grammatical structure and is termed *amphiboly.* "I know that you the enemy will slay." Many of the revelations of the ancient oracles were of this sort. Of course no proposition can be used with assurance as a premise until all ambiguities of meaning have been removed.

EXERCISE.—Put the following arguments in correct syllogistic form, name the type of relation involved, and locate fallacies where they are present. Give the technical name for the fallacies that have one. If the syllogism

uses relations of inclusion and exclusion only, test it by the method of circles while looking for fallacies.

1. Drugs are of no use in cases of sickness, because we must depend on nature to effect a cure.
2. Man is a rational being; therefore a lover's acts are rational.
3. Improbable events happen almost every day. Now events which happen almost every day are probable events. Hence improbable events are probable.
4. Veal from very young calves should not be eaten by people, for it is not fit for human consumption.
5. What you bought yesterday you ate today, hence you must have eaten raw meat today.
6. All generous men provide amply for their families. Mr. L. provides amply for his family, therefore he is a generous man.
7. The bill before the House is well calculated to elevate the character of education in this country, for the general type of instruction in all our schools will be raised by it.
8. All great business men began with small salaries. I began with a small salary, so I shall become a great business man.
9. No cat has nine tails. One cat has one more tail than no cat. Therefore one cat has ten tails.
10. The coldest month of the year is the one following the winter solstice. Therefore the warmest month is the one following the summer solstice.
11. Whatever is right ought to be done. It is my right to build on this property. Therefore I ought to build on it.
12. I was president of this society for ten years. I should think that my plan ought to be adopted.
13. This doctrine is not true, for Scripture condemns those who hold it.
14. I have made this offer so attractive to your pocketbook that you cannot conscientiously refuse to accept it.
15. Mr. X. praised my work highly at the dinner the other night. He must be a man of excellent judgment.
16. Texas is colder than Florida. Therefore Brownsville has not as warm a climate as Pensacola.
17. The Marriot family has produced many inventors. Henry is a Marriot. Hence he must have inventive genius.
18. To criticize the government cannot be right, for if you do it you will be put in jail.
19. The most soothing color is green. That is why nature employs it universally in vegetation.
20. The quantum theory is at variance with accepted mechanical principles. Hence it may be disregarded.

21. There must be something divine about this man, for his appearance is quite uncommon.
22. This man is a good tennis player, and hence will write a good account of the match.
23. There is no need in the world for people to be without money. The people are the government, and the government can make money.
24. "When men are pure, laws are useless; when they are corrupt, laws are broken." Therefore in either case they do no good.
25. Great men have been born in the slums. I was born in the slums. Therefore I ought to be elected Senator.
26. *Mother:* "Nobody eats soup with a fork, Emily." *Emily:* "But I do, and I am somebody."
27. We conceive an infinitely perfect being. Now perfection involves existence, for a being otherwise perfect who lacked existence would not be as perfect as one who existed too. Therefore we must conceive such a being as existent. (The ontological argument for God's existence.)
28. We conceive an infinitely perfect being. Now perfection involves nonexistence, for whatever exists is less perfect than something better which might replace it. Hence we must conceive such a being as nonexistent.
29. We conceive an absolutely wicked being. Now absolute wickedness involves existence, for a being otherwise completely wicked who lacked existence could not be as wicked as one who existed too. So we must conceive such a being as existent.
30. We conceive an absolutely wicked being. Now absolute wickedness involves nonexistence, for nothing existent is as wicked as we can imagine it might be. Therefore we must conceive such a being as nonexistent.

## *Section 10.* CONCLUSION

The formation of good reasoning habits

We may pertinently end this analysis of the conditions of validity, or correct inference, with a general comment. In our personal reasoning the main lessons that need to be learned if we are to reach sound conclusions from given premises are the necessity of avoiding laxity of attention and the substitution of emotional congruity for logical rigor, as well as the importance of making clear and precise the meanings we use and of adhering strictly to such meanings when established. From the standpoint of interest in correct thinking, therefore, no habit is more funda-

mental than the habit of full concentration on our reasoning processes, and of bringing courageously to the light all the premises which we are actually assuming.

Method of analyzing lengthy arguments

But these habits must also be carried over with equal insistence to the analysis of the arguments which others use in the endeavor to convince us of the soundness of their beliefs. Here, however, an added difficulty arises. We find in their speeches and writings not only the rhetorical devices of playing upon our prejudices and interests in clever ways, but also the skillful interweaving of argumentative portions with those of description, exhortation, or the citing of concrete examples in support of the implied premises. All this is apt to carry us along almost beside ourselves, and make very difficult a systematic logical criticism of the reasoning. Accordingly, we need much practice in the dissection of lengthy arguments, in order to acquire facility in the elimination of the logically irrelevant parts and the reduction of the rest to a form suitable for logical testing. The three main steps which must be passed through when we subject material to such a preliminary analysis may be stated as follows:

1. Set aside all logically irrelevant portions, such as merely descriptive matter, exhortation, or flights of fancy, however alluringly expressed.
2. Note what evidence in fact is given for the premises affirmed or assumed as true.
3. Pick out and reduce to separate syllogisms the inferences drawn from these premises to the conclusions we are asked to accept.

Illustration of the method

Let us exemplify these steps by studying a portion of a typical advertisement. Some further material will then be added for the student's own practice.

Around each city is a metropolitan district of a few square miles, the natural trading area of that market. You can prove this to yourself. As you drive in your automobile toward any large city, you know immediately where the metropolitan district begins. At a certain point, you pass from open country, where there are ten to fifteen families per square mile, into suburban and city districts, with a thousand or three or four thousand families per square mile. The transition is not gradual—it is sudden. No

one could go far wrong in marking the actual market boundary lines of any metropolitan city.

Within the metropolitan area, concentration of families per square mile is 145 times greater than in the small town and rural communities outside of that area. The average production per square mile is 500 times greater. The average purchasing power per family is 3½ times greater. Within the metropolitan area, you can get effective newspaper coverage—outside of it you cannot.

It follows that where people and dollars and circulation are concentrated, there is the greatest opportunity for volume selling at low cost.

These self-evident facts have developed the **P+D+C** principle of selecting markets and advertising media.

**P** is population, measured in families, because these are the buying units.

**D** is dollars or annual wealth production, because this is the measure of purchasing power.

**C** is circulation coverage as represented by the percentage of families reached, because this measures your ability to influence the buying habit of the entire market.

The truth will out when **P+D+C** is applied.

On reading this advertisement over a few times, we see that its main argument is reducible to two syllogisms, and as soon as we grasp the general tenor of this argument we are able to disentangle it from the logically inessential phrases. The first syllogism is contained in the first paragraph, and attempts to establish the conclusion that around each city there is a definite metropolitan district of limited area. The overt premise is stated in the fourth and fifth sentences of the paragraph. It is that as one passes from the country to the city district there is a sudden transition from an area of ten or fifteen families to the square mile to one of a thousand or more families per square mile. The implied further premise is, of course, that wherever this is the case there exists a definite metropolitan district. The other sentences simply introduce this overt premise to the reader,

or add the assumption (not proven) that such a metropolitan district constitutes the natural trading area of the city market.

The second paragraph states the minor premise of the second syllogism. The third paragraph, in form, appears to give the conclusion of this syllogism, but when we examine it carefully we see that it is really the major premise, and the conclusion is not specifically stated. Summarized briefly, the syllogism is as follows:

> Where people and dollars and circulation are concentrated is the greatest opportunity for volume selling at low cost.
> The metropolitan area is where people and dollars and circulation are concentrated (omitting the percentages).
> ∴ The metropolitan area furnishes the greatest opportunity for volume selling at low cost.

The fourth paragraph restates the major premise in the form of an advertising policy, while the three following statements present the assumptions made with respect to the methods of measurement involved. The final statement is a quite irrelevant exclamation. It is added because it had been used above in headline form as an attempt to attract the reader's attention.

EXERCISE.—Let the student try his hand at analyzing the following in same manner:

### 1. "ANOTHER TRIAL FOR DAUGHERTY[1]

"There are conclusive reasons for the second effort of the United States government to convict Harry M. Daugherty, former federal attorney-general, and T. W. Miller, former alien property custodian, of the offense with which they are charged in a criminal indictment. The first trial, in New York city, ended in disagreement of the jury.

"It was asserted in various quarters after the first trial that the district attorney and his assistants had not brought out all the facts against the defendants. Indeed, it was said that some witnesses who knew a good deal about the conspiracies to defraud the government in connection with sales of alien property, and who would have given important testimony, were not summoned at all, though they were ready to take the stand. There were rumors of unclean politics and of campaign-fund transactions that were supposed to require the shielding of the reputations of certain persons now dead.

[1] From the *Chicago Daily News,* February 10, 1927.

"In these circumstances, the government could not help feeling that, despite some talk of persecution, its plain duty was to direct a retrial of the case. The charge in the indictment is not bribery, but conspiracy to defraud the government of the efficient services of the defendants—a conspiracy which is said to have led to the payment of large sums of money to the defendants in return for the authorization of the sale to a Swiss corporation of the assets of the American Metal company, confiscated by the government after the declaration of war in 1917.

"It is understood that only the expiration of the period named in the statute of limitations precluded a direct charge of bribery. The actual charge specified in the indictment is not outlawed, while the facts which would have sustained the allegation of bribery also sustain that of conspiracy to defraud the government.

"Presumably the second trial will be so conducted as to leave no reason for the suspicion that damaging facts were suppressed or ugly political secrets were kept dark."

"Give the Kiddies Bread and Butter Often at Playtime"

"Keep the boys and girls more immune from cold and damp by keeping them well nourished—constantly well nourished by liberal slices of bread and butter—bread made with pure, sweet milk, yeast and the best of flour. A full stomach warms the whole body. Its beneficial influence on sturdy health is acknowledged by every doctor in the land.

"Ward's Fine Bread made with milk is 'truly the staff of life.' It contains all the ingredients of the perfect loaf of bread according to experts' specifications AND NOTHING ELSE. The preferred loaf of wholesome bread for the health of your family and yourself is Ward's Fine Bread. AT YOUR GROCER'S. 'TASTE IT! IT'S WARD'S.' "

3. BUY YOUR MOTOR CAR THIS WAY—

Ask us for a car to drive . . . Make your own tests and comparisons . . . Let the car sell itself. If it does not *meet your requirements* better than any other car, you will not be asked to buy.

**Two Vital Questions:**

**1—What is the greatest change in the automobile industry today?**
**2—What car best meets this change?**

**Verify These Answers:**

The change that is having the greatest influence in affecting the trend of the entire automobile industry today, is not IN the industry—IT IS IN THE PUBLIC.

The tables are turned.

For years engineers and manufacturers TOLD the public "what was what." If one engineer had a pet theory he said IT was the best. Another manufacturer said HIS was the best. The public has tried them all, and learned one thing—it is not what the manufacturer says but WHAT THE CAR SAYS in service that counts. This, that and the other "feature" is meaningless unless the RESULTS are there. People no longer buy "motors," or "parts" or "specifications." They buy what THE WHOLE CAR DOES—how WELL it does it—and how LONG it does it.

Today the PUBLIC says "WHAT'S WHAT."

Buyers are doing THEIR OWN THINKING. The average car owner has paid several thousands of dollars for his experience. He now knows what he wants a CAR TO DO and HOW he wants it to do it. He can JUDGE FOR HIMSELF whether the car does it. He needs no salesman to tell him what he wants.

And, knowing what he wants, he is on the search for the car THAT BEST MEETS HIS REQUIREMENTS.

Auburn was at least TWO YEARS AHEAD of the entire automobile industry in sensing this inevitable change. Auburn was FIRST to build a motor car so well that IT WOULD SELL ITSELF. This radical change demanded cars be BETTER BUILT than ever before.

Auburn's policy instantly won public confidence. People investigated the cars. Auburn's sales increase is phenomenal. If some one of the new Auburn cars does not meet your requirements IN EVERY WAY better than any other car, you will not be asked to buy.

4. "To the Senate: The conditions which senate bill 4808 is designed to remedy have been, and still are, unsatisfactory in many cases.

"No one can deny that the prices of many farm products have been out of line with the general price level for several years. No one could fail to

want every proper step taken to assure to agriculture a just and secure place in our economic scheme.

"Reasonable and constructive legislation to that end would be thoroughly justified and would have the hearty support of all who have the interests of the nation at heart. The difficulty with this particular measure is that it is not framed to aid farmers as a whole, and it is, furthermore, calculated to injure rather than promote the general public welfare.

*Sees Remedy in Diversification*

"It is axiomatic that progress is made through building on the good foundations that already exist. For many years—indeed, from before the day of modern agricultural science—balanced and diversified farming has been regarded by thoughtful farmers and scientists as the safeguard of our agriculture.

"The bill under consideration throws this aside as of no consequence. It says, in effect, that all the agricultural scientists and all the thinking farmers of the last fifty years are wrong; that what we ought to do is not to encourage diversified agriculture, but instead put a premium on one crop farming.

"The measure discriminates definitely against products which make up what has been universally considered a program of safe farming. The bill upholds as ideals of American farming the men who grow cotton, corn, rice, swine, tobacco, or wheat, and nothing else.

*Bill Bestows Special Favors*

"These are to be given special favors at the expense of the farmer who has toiled for years to build up a constructive farming enterprise to include a variety of crops and live stock that shall, so far as possible, be safe, and keep the soil, the farmer's chief asset, fertile and productive.

"The bill singles out a few products, chiefly sectional, and proposes to raise the prices of those regardless of the fact that thousands of other farmers would be directly penalized. If this is a true farm relief measure, why does it leave out the producers of beef cattle, sheep, dairy products, poultry products, potatoes, hay, fruit, vegetables, oats, barley, rye, flax, and the other important agricultural lines?

"So far as the farmers as a whole are concerned, this measure is not for them. It is for certain groups of farmers in certain sections of the country. Can it be thought that such legislation could have the sanction of the rank and file of the nation's farmers?

*Government to Pay Losses*

"This measure provides specifically for the payment by the federal board of all losses, costs, and charges of packers, millers, cotton spinners, or other

processors who are operating under contract with the board. It contemplates that the packers may be commissioned by the government to buy hogs enough to create a near scarcity in this country, slaughter the hogs, sell the pork products abroad at a loss, and have their losses, costs, and charges made good out of the pockets of farm taxpayers.

"The millers would be similarly commissioned to operate in wheat or corn and have their losses, costs, and charges paid by farm taxpayers.

"It is roughly estimated that in this country there are 4,000 millers, over 1,000 meat packing plants and about 1,000 actual spinners. No one can say definitely after reading this bill whether each of these concerns would be entitled to receive a contract with the government.

### *Calls Plan Incredible*

"Certainly no independent concern could continue in business without one. Each of the agencies holding a contract—the efficient and inefficient alike—would be reimbursed for all their losses, costs, and charges.

"It seems almost incredible that the producers of hops, corn, wheat, rice, tobacco, and cotton should be offered a scheme of legislative relief in which the only persons who are guaranteed a profit are the exporters, packers, millers, cotton spinners, and other processors.

"Clearly this legislation involves governmental fixing of prices. It gives the proposed federal board almost unlimited authority to fix prices on the designated commodities. This is price fixing, furthermore, on some of the nation's basic foods and materials.

"Nothing is more certain than that such price fixing would upset the normal exchange relationships existing in the open market and that it would finally have to be extended to cover a multitude of other goods and services. Government price fixing, once started, has alike no justice and no end. It is an economic folly from which this country has every right to be spared.

### *What Legislation Proposes*

"This legislation proposes, in effect, that congress shall delegate to a federal farm board, nominated by farmers, the power to lay and collect a tax, called an equalization fee, on certain products produced by those farmers. That certainly contemplates a remarkable delegation of the taxing power.

"The purpose of that tax, it may be repeated, is to pay the losses incurred in the disposition of the surplus products in order to raise the price on that portion of the products consumed by our own people.

"This so-called equalization fee is not a tax for purposes of revenue in the accepted sense. It is a tax for the special benefit of particular groups. As a direct tax on certain of the vital necessaries of life, it represents the most vicious form of taxation. Its real effect is an employment of the

coercive powers of government to the end that certain special groups of farmers and processors may profit temporarily at the expense of other farmers and of the community at large.

*Denies It Would Help Farmer*

"The chief objection to the bill is that it would not benefit the farmer. Whatever may be the temporary influence of arbitrary interference, no one can deny that in the long run prices will be governed by the law of supply and demand. To expect to increase prices and then to maintain them on a higher level by means of a plan which must of necessity increase production while decreasing consumption, is to fly in the face of an economic law as well established as any law of nature." [1]

[1] From the message of President Coolidge vetoing the McNary-Haugen bill, February 25, 1927.

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## CHAPTER EIGHT

# VERIFICATION IN PRACTICAL PROBLEMS

Verification in general

IN CHAPTER FOUR we noted that certain types of problem demand a fifth step as an essential part of the process of thinking which constitutes their attempted solution, namely verification in the form of appeal to empirical fact to see whether the implications of a suggestion as reasoned out in step four are really present as supposed. The most important of these types is that whose guiding purpose is to explain some object or event which can be pointed out and dealt with concretely in the form of sense-observation or experimentation. But to secure such explanations is precisely the general task of the various branches of empirical science, and a careful examination of the method of these sciences as revealing the best technique of verification in problems of this kind is accordingly one of the most important tasks of a systematic treatise on logic. We can hardly fulfill this task adequately in the scope of a single chapter on the conditions of right verification. We shall accordingly incorporate a study of these conditions, so far as scientific problems are concerned, in the ensuing part of the book, where scientific method in general will be discussed as the application of the principles of right thinking within the realm in which objective empirical tests appear to be possible, by contrast with the realm dealt with in the final part, in which such tests do not appear to be possible. A discussion which might seem to be most pertinent at this point of Part II it is therefore necessary to postpone for the moment. The postponement will be the less confusing, inasmuch as there are types of problem, as we noted, such as those in pure mathematics and practical situations where time presses, which terminate with the fourth step.

But we also observed that problems of the scientific kind are not the only problems which permit experimental verification. Those practical problems in which time is not so pressing but that we may test further suggestions after the first has failed, also permit such verification. What are the essential conditions of correct verification in their case?

Practical experimentation

Only a very brief and simple answer seems possible to this question, and with it we shall terminate the present analysis of the conditions of right thinking at each step of an act of thought. This type of problem was illustrated earlier, but let us illustrate it anew as a helpful preliminary to the present discussion.

Illustrated anew

I need to make a trip to a point on the west side of the city, and the question arises what conveyance to take. Usually I take the bus when going there, for it passes directly by the door of the building I wish to reach. But as it is a bitter cold day I wonder whether I could keep comfortably warm in the bus. The suggestion occurs to use the elevated instead, and in developing its implications I recall that if I do this I shall have a walk of only two or three blocks. But these are long blocks and are entirely open to the wind. Is there any way in which I can avoid them? In comparing the alternatives I recall that the bus, after a ride of about six minutes, directly passes a station on the elevated line. Accordingly I decide to take the bus tentatively, and after finding out how warm it is during those six minutes decide finally whether to remain in it or to transfer to the elevated. As an aid to the solution of this practical problem, then, we have an experiment resorted to—the six minutes' ride in the bus constituting the experiment—and the act of thought is not entirely terminated until the decision is made whether to stay in the bus or take the elevated for the rest of the journey. The bus at first is resorted to only hypothetically—it is a candidate for acceptance rather than accepted definitely until it is tested through experiment.

The type of problem thus exemplified includes all those cases where either through greater time for action or through special opportunity for retracing one's steps it is possible to try out

various suggested modes of action without committing oneself finally in advance to any of them. They are the cases, so to speak, where we do not have to place our entire stake at once, but can actively try out the alternatives that seem to be worth trying before such final acceptance. Fortunately, many of our practical problems are of this sort. It is obvious that where such experiment is available, and where alternatives seem otherwise pretty evenly balanced, the experiment adds greatly to the intelligence of the ultimate decision.

Its essential conditions

What are the conditions of the correct performance of such experiments?

Since the suggestion in a practical problem is of something to do in a concrete situation, and since the action which may be needed is as infinitely varied as the distinguishable situations themselves, it seems impossible to pick out any common characteristics which could afford us any guiding principle here. *Do whatever it is that the suggestion tentatively taken indicates, and see by the doing what suggestion is to be finally accepted for the problem as a whole.* The only logical requirements are that the proposed action be within our power, not out of proportion, in time and energy consumed, to the urgency of the problem, and that we keep the problem clearly in mind during its performance. It is only when the thing to be done is controlled by a more limited purpose capable of precise definition, as in scientific problems, that it is possible to outline these conditions in greater detail. Without such limitation, the activity constituting the experiment may vary in quite unpredictable ways.

Limits of pragmatic experimentation

It is desirable at this point to state more fully the reasons which involve limiting the conception of pragmatic experimentation to the type of situation above described.

Suppose, as a result of an act of reflection, I commit myself unreservedly to a certain line of conduct, and later, finding that it does not yield the satisfaction I expected, reconsider the problem. Shall we call the experience between the commitment and the reconsideration an experiment like the experiment described above? In favor of doing so is the fact that after the recon-

sideration has begun, the intervening period does play the rôle of an experiment, and the fact that the problem is fundamentally the same, as is indicated by the fact that we do not take it up entirely *de novo,* but at the point where subsequent experience has shown inadequacy in the previous decision. Against doing so lies the fact that the original decision was made without reservation, and accordingly that particular act of thought, psychologically at least, terminated with it. The reconsideration is psychologically a new piece of reflection. What shall be our choice as between these alternatives? It is in part a verbal matter as to the most convenient use of our terms, but if we are to mean by an act of thought a unit of mental activity verifiable as such by empirical psychological analysis, we must regard the reconsideration in this case as a separate piece of reflection. For, after all, the problem is different in a decisive respect. It is now: Shall I continue in the action on which I have already entered, in the light of the previously unforeseen events which have cast doubt on my previous decision? Whereas in the case described above, the problem is held open during the tentative activity, and it is accordingly the same problem still that we are facing if that activity proves unsuccessful. The former piece of thinking then terminated with the fourth step, and its results enter in the later reflection as clarifying observations at the second step.

**Is practical experimentation a social process?**

The same answer must be given to another question that may be pertinently raised. May we think of pragmatic experimentation as a social process, in the sense that we might view the historical development of the solution of a problem, through the work of several thinkers each building upon his predecessor's achievements, as a single act of thought? There are several interesting examples in the history of science which it seems natural and helpful to describe in this way. One of these is the discovery of the mechanical equivalent of heat. Certain investigators, such as Count Rumford and Sir Humphry Davy, showed that the prevalent explanations of heat were impossible, while the hypothesis which they were unable to verify systematically was later satisfactorily demonstrated by J. P. Joule.

In terms of a broad view over the historical development of a problem, it is thus clear that the more important contribution of one man may be the clarification of a problem, of another the fruitful hypothesis, of another the successful experiment. It may seem desirable then to describe the whole development as a single act of thought. But if we do picture the matter in this way we must be careful not to imagine that one thinker suggests a hypothesis and does nothing else, while another experiments on it and does nothing else. We know of no social mind which thus distributes the separate steps of its thinking over various individual minds. There is something to be placed in each of the steps in the work of each collaborator, and a describable unit of reflection is thus psychologically something that takes place in an individual mind.

Moreover, it is just when we consider practical rather than scientific experimentation, that this extension of the term to describe a social process is most to be deprecated as logically confusing. Shall we talk, for example, of the experiment of the entire human race with such institutions as the family, aristocracy, private property, and the like? Surely this is a seriously loose way of using the term. When anybody today faces a perplexity about such social institutions, the previous experience of mankind with them always functions in step two of his thinking, as aiding in the clarification of his problem, never in step five as an experimental testing of his own suggestions as to what he ought to do about them. If his choice is tentative, it is made final by his own further experience of a specific sort.

# *Part III*

# SCIENTIFIC METHOD AS THE OBJECTIVE REALIZATION OF THE CONDITIONS OF RIGHT THINKING

CHAPTER NINE

# THE ASSUMPTIONS OF SCIENTIFIC VERIFICATION

*Introduction and outline*

IN PART I we had occasion to refer to science as both a purpose and an institutional enterprise. As the former, we saw, it stands for the conscious effort to establish dependable connections in our thinking, in place of superstitious emotional associations. As the latter, it is the expression of this purpose in institutional form, involving the coöperation of many individuals interested in this end, and the development of an apparatus and technique, both intellectual and mechanical, for verifying hypotheses of such orderly connections. It is time now to examine science in the latter sense in somewhat fuller detail, with special reference to this technique of verification. Let us first broaden and fix more precisely our conception of the nature of science in relation to the inquiries which have so far occupied us, and then advance gradually from the assumptions revealed in the scientist's verification of specific hypotheses in the fifth step of his problems to the broader principles exemplified in the historical growth of scientific knowledge from a mass of disconnected qualitative relationships toward a more unified, precise, quantitative system of truths. The discussion of functional explanation in chapter eleven will mark the transition from the former inquiry to the latter.

*The nature of empirical science*

In the first place, consider briefly the essential difference between empirical science and other types of reflective thinking. As contrasted with reflection focused upon practical exigencies, this kind of thinking is not limited by the necessity of action on the basis of the best available result within a particular time, and it expresses on the psychological side the interest in simply understanding how things happen in our world rather than the

interest in modifying what happens for the sake of some desired result. In the first of these respects it is like the mathematical thinking discussed in chapter four; in the second it is different from mathematical discovery, too. For the latter is a form of creative play; it is the elaboration of a system of meaning-relations quite without reference to the physical objects or events to which those relations might under other circumstances be applied. But the investigations of empirical science, while genuinely creative, are controlled from first to last by such a reference. Scientific problems of this sort are accordingly problems whose guiding purpose is precisely to reveal the laws according to which events in the physical world take place—to explain nature, in short.

**What is meant by explaining empirical facts?**

But just what does it mean to explain an event, to understand it in terms of the laws of its behavior? We have already assumed an answer to this question; let us see how it can be justified. If we examine what we do in every attempted explanation of anything, we shall discover that what we are always seeking is a regular relation between the thing to be explained and something else. You cannot explain anything merely by repeating the thing itself, nor by just pointing it out to somebody. You appeal to something else that is always present when the thing is present and (if possible) always absent when it is absent. Thus we explain a poor corn crop by referring to frequent storms in the corn belt; we explain Johnny's cold by his playing in the melting snow yesterday; we explain the cold water of the lake by a recent offshore breeze. Similarly, Newton explains the orbital motions of the planets by showing them to be instances of the laws of falling bodies established by Galileo, and Joule explains heat by correlating it with increased molecular motion within the heated body.

**Why explain in universal terms?**

Why do we demand that the relation of an event which is thus picked out to explain it be a regular and dependable one? The fundamental answer to this question seems to be that the basic needs of human nature which express themselves in the search for explanations are of such a sort that only regularity satisfies them. If the need be that of theoretical curiosity, it is

evident that it is not appeased when we are told that B sometimes happens when A happens; we push on to discover, if possible, an event C which always happens when A happens, whose connection with it is therefore universal. Still clearer is this demand for regularity when our need is the practical one of controlling A, of making it more subservient to our welfare. In this case our problem is to discover a connection between A and some other event which is easily within our control, so that by bringing about the latter we shall insure the occurrence of A, or by preventing it insure A's nonoccurrence. Obviously, if the connection is not regular the control achieved by knowledge of it is precarious. On both these accounts it is essential to genuine explanation that the connection appealed to be capable of expression in universal terms. This is but another way of saying—in terms of scientific law.

Moreover, in the second place, by stating the nature of scientific inquiry in this way its significance for all the rest of our thinking becomes at once clear. For at each preceding step of every act of thought we are taking it for granted that there are certain regular and dependable relations between the objects and happenings that compose our physical world. Let us develop this point somewhat more fully.

**Dependence of all reflection on the assumption of such relations**

It would certainly be impossible to clarify the meaning of a difficulty so that we could entertain fruitful suggestions for its solution, if we did not assume that the same relations will hold of the present situation that we have observed to hold of similar situations in our previous experience. I could not even, for example, clarify the problem how to eat a tropical fruit just sent me, if I did not assume dependable relations between the feeling of softness and the juiciness of the pulp, between the texture of the skin and the structure of the interior, and take for granted also the fundamental mechanical relations which govern my use of knife and spoon; in fact, without such assumptions I could not even apply a definite name to the object, for the use of a single name for the piece of fruit presupposes regular relations between the perceptual qualities that compose it —its shape, color, smoothness, sweetness, and the rest.

We observe also that without the assumption of such relations or laws, suggested solutions of the difficulty could hardly occur to one's mind. Suggestions always consist centrally of the recollection of ways that successfully solved earlier problems in this or that respect similar to the present problem. But in a world which seemed to be wholly chaotic, in which, so far as our knowledge went, anything might be connected with anything, there would be no reason why one suggestion should come to mind rather than another. If all of A's relations have been different every time A has occurred, there is nothing to determine the mind to recall any particular one of those relations rather than another when A occurs again. Memory would be completely neutral as between them, or, if it were determined in some specific way, it would be by some logically quite irrelevant factor that happened to appeal emotionally. One might indeed make out a good case for the position that in such a world memory itself would be impossible.

Especially in deductions from suggested solutions

Still more clearly, if anything, do such assumptions play an inevitable part in our thinking in the elaboration of the bearings of a suggestion. In the chaotic world just hypothesized no proposition about anything would have any implications at all. For to argue that because one thing is true another must be true is to assume a universal relation between them. To illustrate by the time-honored syllogism of the scholastics, it is impossible to conclude that because Socrates is a man he is therefore mortal, unless we presuppose a regular relation between humanity and mortality, which presupposition is expressed as a law in the major premise: All men are mortal. Were there no such regular connections, nothing could be deduced from any statement, for in one situation one consequence might appear, and in another quite a different one. Each statement would have to stand entirely by itself, if, indeed, it could have any definite meaning at all. It is fundamentally for this reason that the rule holds for syllogisms of inclusion and exclusion that one of the premises must be universal or else no valid conclusion can follow.

All this is tantamount to saying that no reflective thinking of any sort can occur without the assumption of regular relations, statable in universal laws, as obtaining between events in our experience. It is therefore of the utmost importance for correct thinking that those relations which we assume to be dependable, the laws we rest upon as universal, really are such. Otherwise our thinking will be likely to run astray at every point, or at least lack the degree of assurance that might be attainable. And in Part I we found reason to suspect that many of the connections which people assume to be dependable in their thinking are not really so at all. To believe in them is to rest on superstition, not knowledge.

**Fundamental importance, therefore, of verified relations**

Hence there is peculiar importance for all our thinking in the correct solution of the type of problem which science as a conscious enterprise attempts to solve. And it follows that all our thinking is in jeopardy unless we pursue the right method in dealing with those problems whose peculiar purpose it is to establish verified universal laws of the connections between things. *Science is that unique human enterprise whose aim is precisely to correct and extend our knowledge of the general laws, the truth of some of which we are assuming whenever we think.* To view science in this light is to appreciate its supreme importance in the advancing life of humanity. Reflection is the most effective method of solving all human problems; scientific knowledge is the only sound foundation of reflection.

Moreover—and this is a third important point—in scientific problems the crucial step is the fifth step, that of verification through observation or experiment. In advance of such verification a suggested law is a hypothesis merely, not a law in the proper sense at all. It must be shown to be in agreement with the experienced facts to which it refers, and until that agreement has been clearly demonstrated the hypothesis has not been verified. We may, indeed, have frequently to act on hypotheses which have not been adequately verified from a scientific standpoint, when action is demanded and a given hypothesis seems more plausible than any of its alternatives; but then our problem is a practical, not a scientific one. It is just the business

**Verification constitutes the fifth step in a scientific problem**

of science to retire from practical exigencies sufficiently to be able to solve its problems without temporal pressure, and contribute to subsequent practical needs more dependable laws for reflective guidance than would otherwise be available. Hence no subject in logic is more fundamental than the study of scientific method as revealed in the technique of observation and experiment that the scientist applies when endeavoring to verify, in the fifth step of his own problems, a suggested universal law. In its other phases, as expressed by the first four steps of Dewey's analysis, the scientist's thinking reveals no special characteristics beyond those which have been examined in the preceding part of the volume. The conditions of right thinking there noted apply to scientific inquiry in the same way as to all other types of thinking. But because the scientist's purpose is of a definite and peculiar sort, the verifying activity that is decided upon as a result of the evaluation of suggestions in the fourth step must in his case be guided in a very definite way.

What is this way? What are the correct methods and assumptions of this process of scientific verification?

The attempt to answer this question will soon lead us to lay down two principles which express the general conditions of correct verification. But before we proceed to their derivation and analysis, two other matters need brief discussion. They will aid our general orientation in treating the nature of scientific method.

**Explanatory relations not always causal**

The first is that John Stuart Mill, father of modern analysis of scientific procedure, and indeed practically all other inductive logicians, state these principles as though they supposed explanatory connections always to be causal connections, and that experimental verification is always of the supposed causes of certain effects. Now, to be sure, in a loose way, we often use the term cause as applying to almost any fact appealed to as explaining another; we call the law of gravitation the cause of a stone's fall, the fall itself the cause of the resulting impact, and our own absence from the spot the cause of our escaping injury. Here are three quite different uses of the term. None the less, this limitation of the statement of these principles is

unfortunate in two ways. For one thing, we presuppose many regular relations in our thinking which we do not ordinarily describe as causal connections. The connection of the shape and color of an orange, earlier instanced, or of day and night, reveal types of relation which are just as fundamental to our thinking, and which demand the same type of verification, as causal relations, but which we do not think of as causal. For another, as we shall attempt to show in due time, preoccupation with the concept of causal connection is the sign of a relatively early stage in the development of a given science. A causal explanation, as ordinarily used, lacks a certain thoroughness and system, and with the growth of science tends to pass away in favor of a more thorough and organic type of explanation in which the concept of function plays the central rôle. But the rules of experimental verification are just as vital for the establishment of functional as for causal relations. In our exposition, accordingly, while many illustrations will be drawn from connections which would naturally be called causal, our purpose will not be limited to an account of causal connections merely, but will be directed toward the more general principles of observation and experiment which are involved in the verification of any type of regular relation whatever. It is our attempt to understand how any universal law, hypothesized to hold between two events, is shown to be really what it claims to be.

**That is objective on which social ... nitely be secured**

The second preliminary point concerns our use of the term "objective" in the title of this part of the book. What is meant by speaking of empirical science as the *objective* application of the principles of right thinking?

Fundamentally, that is objective which can be pointed out to other people in the same way in which it can be demonstrated to ourselves, provided that they are normally conditioned as to sense organs and nervous structure. This means ordinarily that any verification of a hypothesized law which can be termed objective must concern itself with facts that any normal person can observe through the senses, and involve processes which anyone who understands what the purpose is can repeat, and

by repeating see for himself that the verification is correct. The objective realization of the principles of right thinking is thus their application in such a way, and over such a field, that social agreement can actually be secured as to the validity of the result.

If some one questions my statement that the sun warms, I can lead him to situations in which this regular connection is forced upon him in the same empirical way in which it has been forced upon me; I can bring him back and forth from sunny to shady spots, show Weather Bureau statistics of comparative temperatures on clear and cloudy days at the same season of the year, and appeal to many other facts to which he can hardly be blind and which are only thus explicable. But suppose the question arises: Is this day warm enough to go for a picnic on the beach? How can a hypothesis as to this be verified in the same overt, tangible way? He might affirm that it was warm enough, while I might strongly doubt whether it would be advisable to hold the picnic. How can either belief be verified in the same compelling way in which the relation between the shining of the sun and increased temperature can be verified? The latter instances, on a simple, common-sense level, the type of thinking to which the term objective applies; the former, by contrast, is weakened and confused by factors which are inherently subjective. It will be the task of the following part of the volume to develop this distinction in a thoroughgoing way; suffice it to note here that empirical science is concerned basically with verification of the objective type. Should a man question the validity of any scientific law, the scientist can say to him, "If you are sincerely anxious to know whether this is a sound result or not, come with me and repeat the observations which have led me to it." It is just this important characteristic of scientific thinking that we wish to call attention to by speaking of scientific method as the objective application of the principles of right thinking.

Objectivity does not, of course, inherently demand direct reference to what has been observed through the senses. This is shown by the objectivity of the mathematical sciences, which,

though consistent with experience, can be seen to hold true by all normal persons without necessary appeal to verification. So far as the principles of right thinking here discussed are objective, they are so in a manner similar to that of mathematics.

Guiding assumptions of empirical verification—agreement

With these preliminaries we may now attack the two essential assumptions revealed in the verifying procedure of empirical science. In describing these we shall follow in general the terminology made classic by John Stuart Mill in his *System of Logic,* though our analysis as a whole will vary considerably from his.

### A. THE FIRST PRINCIPLE OF VERIFICATION—AGREEMENT OF INSTANCES

Here our underlying assumption is simply that *any fact A is regularly connected with another fact B if, whenever it is present, B is found to be present likewise.*

This principle is so clear and so completely supported by common sense that it is necessary to illustrate it only for the sake of bringing out the precise manner in which it must be applied. Suppose I have observed that a number of roses have thorns. Being in a curious mood, or otherwise interested in the matter, I entertain the suggestion that all roses have thorns—that is, that the connection holds good as a universal law. How should I guide my observations so as to see whether this is the case or not? Of course, this happens to be a matter where authoritative scientific knowledge has now been secured, and if I did not wish to waste my time I should simply consult a scientific article on roses, such as an up-to-date encyclopedia would furnish. But we shall suppose that I live in a primitive age when such knowledge is not yet available. How shall I proceed to verify my hypothesis? Surely the most natural method to follow first would be the one directly implied by the principle of agreement. I should visit gardens and conservatories, florists' shops, and the like, and if after observing all the roses that I found in such places there proved to be thorns on all of

them, I should begin to regard the connection as pretty well established.

Negative implication of this principle

But it is obvious that a cursory survey of this sort is hardly adequate to verify the hypothesis of a universal connection. There is an important negative implication of the principle of agreement, and unless we recognize it fully and take it into account in our procedure, we are on the level of popular beliefs somewhat emancipated from emotional control rather than the level of exact science. It is by the method of agreement in the loose form just exemplified that many beliefs handed down from primitive times were established, such as the belief that a hearty meal makes one drowsy, that a soft answer turneth away wrath while grievous words stir up anger, and the like. It is evident that there are many exceptions to these generalizations, and when the attitude of exact and responsible science has appeared exceptions will not be brooked.

We recognize the full significance of the principle of agreement only when we take into account its negative implication. This may be brought out by restating in negative form its underlying assumption, as follows: *No fact A is regularly connected with another fact B if we can find cases of the former in which the latter is absent, and the connection is the more certain in proportion as we have found no such case in a larger variety of instances of A.*

Here the key phrase is "larger variety of instances." We come to realize, in other words, that it is illegitimate to affirm a universal law relating A and B merely because all the cases of A that have come under our notice were accompanied by B. To affirm such a law implies that there is no case of A to be found in which B is absent.

The hypothesis must be tested under varying circumstances

But it is evident that if this negative implication be clearly held in mind, we must undertake the responsibility of a much more extensive and careful study than a casual survey secures. We must make sure, so far as we can, that there are no circumstances or conditions under which A occurs without B. Hence we must study A under all the various circumstances in which it appears, and see whether there are any circum-

stances in which B fails to appear. To revert to our illustration, we must observe roses growing under as many different conditions as we can. To make the investigation really complete we should travel to distant countries with different climates and varied soil, examining roses in all of them that produce any. Thus alone could we reduce to a minimum the possibility that roses of a particular locality only, or growing under specific conditions only, had thorns. But if a systematic inquiry thus guided brought to light no cases of roses without thorns, we should affirm with a much larger degree of confidence that all roses had thorns. In our further thinking, then, we should regard the connection of thorns with roses as a pretty dependable one, the more dependable in comparison with our other beliefs as it had been verified by more thorough observation. Roses would come to imply thorns, the more certainly as the investigation that I had made were the more careful and complete.

It is interesting and important to note that the reasoning process in the fourth step which leads up to and guides observation in the fifth step of a problem of this sort, consists in affirming in some form the assumption of the principle of agreement. That is, the suggestion having occurred that all roses have thorns, we develop its implication as follows: If all roses have thorns, then under whatever conditions I find a rose I shall also find thorns on its stem. What ultimate justification we have in making such an assumption will soon be considered.

**Possibility of hasty generalization**

What, now, are the essential inadequacies of this principle of agreement, as used to verify the hypothesis of a law of connection?

First, there is the fundamental inadequacy of all inductive formulæ, namely that it is impossible to state any specific point in the course of our investigation at which we may legitimately stop and say that our hypothesis has been completely proved. For it is clear that we can never be sure, however careful our study has been, that all possible varieties of roses have been included in its scope. Accordingly, we can never be sure that our asserted universal law does not rest on the strength of an

insufficient number of instances, or on the strength of instances too similar in their context. Even were all present and past roses taken into account (which would be impossible in practice), roses of the future could not in the nature of the case be included. This is an inadequacy inherent in all inductive generalization, that our laws cannot be verified as absolutely certain.

This is particularly unfortunate because of the fact that the besetting tendency of the human mind, even when it has acquired some discipline in the habit of checking belief on the basis of mere vividness or recency of experienced connection, is to commit the fallacy known in logical parlance as hasty generalization, or in Latin phrase, *post hoc ergo propter hoc*. The other day I heard a friend remark in the washroom of our club, "They're using smaller towels here than they used to." My experience not confirming this statement, I inquired on what evidence it was made. It developed that two successive towels he had picked up were smaller than usual, and on this meager basis he had inferred a universal law. Doubtless in this case the holding of a belief on insufficient evidence would not lead to very serious consequences, but such is not the case with many beliefs which have been accepted on as little, or less, empirical evidence. The belief that religious scepticism is inseparably connected with immorality, which has supported hideous persecutions in many ages, is a case in point. And it is difficult to control this tendency as it needs to be controlled, when we see that, no matter how systematic our observation has been, it is still possible that we are generalizing too hastily.

Moreover, of course, it is not possible for all of us to verify with even passing thoroughness all the connections which in our thinking we assume to be universal. The vitally important lessons, therefore, to be mastered in this situation are two. One has been earlier discussed, but will bear repeating—that we should distinguish between beliefs on the basis of the adequacy with which they have been verified, and regulate the measure of our acceptance accordingly, and that we should know where to turn for the most dependable available knowledge on any

given subject and form the habit of using it rather than the fruits of superstition or quackery. Even, indeed, when we have to commit ourselves to action on the strength of meager evidence, as the doctor often does in his treatment of patients, it is not necessary to suppose the truth thus assumed to be any more dependable than the evidence warrants. The second lesson is that when we affirm a universal law as a result of scientific investigation we should describe the steps of our inquiry so that others can see how thorough we were able to make it and how unlikely, therefore, exceptions to it would be, while accepting the responsibility to make it as adequate as our time and means permit. If the possibility of hasty generalization cannot be wholly avoided, we can rob it of its logical danger by recognizing in each case just how hasty our generalization has been.

Our chosen illustration itself reveals the desirability of these precautions. For the reader familiar with flowers will know that there are thornless roses, although an investigator might happen to observe widely and experiment considerably before he discovered them.

**Agreement establish one-many relations only**

But there is a second inadequacy in the application of the principle of agreement merely, which is not inherent in inductive generalization, and which, therefore, may be corrected by combining with it another principle. We may establish by it one-many connections only between events. That is, we may know with considerable assurance as a result of such study that given A, B may be expected to be present, but we do not know at all that, given B, A must have been present. And of course, where this is the case, our understanding and control of the relation is a merely one-many understanding and control. To produce B we can produce A, but if we wish to avoid B we do not know what to do, for there may be some other event C, which, if given, will bring about the appearance of B also. Thus a certain stroke with the cue will result in a definite motion of the billiard ball, but if that motion has taken place we cannot be sure that the stroke in question preceded. For there are other causes that might have brought it about, such as a sudden brush with the elbow.

Hence needs to be supplemented by the principle of difference

Accordingly, science seeks where possible to advance to a mode of analysis transcending that implied by the principle of agreement alone. It seeks to develop laws of relation between events which are reversible, that is to say, laws expressing such a connection between A and B that each is universally present when the other is present: given A, then B; given B, then A. The type of law thus established is far more valuable than the type expressing a one-many connection only.

The essential principle involved in the idea of agreement of instances, we saw, was that it establishes a connection such that wherever A occurs we may be sure that B occurs likewise. A simple way of stating the added principle whose combination with that of agreement makes possible reversible connections, is that it also raises the question whether, whenever A is absent, B can be counted on to be absent likewise. Again following Mill's terminology where it seems helpful, we shall set forth

### B. THE SECOND PRINCIPLE OF VERIFICATION—THE CORROBORATION OF AGREEMENT BY DIFFERENCE

As just implied, the essential assumption here added is, that any fact A is universally connected with another fact B if, whenever it is absent, B is always absent likewise. It is evident, of course, that our illustration of the thorns and roses instances a one-many connection merely, and will not exemplify this new principle. For thorns are connected with other plants than roses; the latter may be absent and thorns still be present. It is helpful to compare the two principles in the light of the type of implication which their results make possible, as follows:

Principle of Agreement—If A, then B.

Principle of Difference—If non-A, then non-B.

Now, as our statement of this second principle suggests, it is never used in scientific verification apart from the principle of agreement, hence it is foolish to seek examples of it *in abstracto*. The way in which the two principles are combined in actual scientific use will hence occupy us in the next chapter. We

shall first consider them as combined under conditions permitting little more than simple observation, and even as thus combined they illustrate a type of procedure and reach a kind of result that is far superior to that of the principle of agreement alone. Then we shall note what added strength is secured when conditions permit supplementing observation by active experiment.

For shorthand purposes we may refer to this combination of the two principles in scientific inquiry as the *Joint Method.* Let us see how laws are established by it.

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CHAPTER TEN

# THE ESTABLISHMENT OF LAW BY OBSERVATION OR LABORATORY EXPERIMENT

An illustrative problem

SUPPOSE ourselves living in a day of less knowledge about typhoid fever than now, and a number of people in our community suddenly fall ill with the disease. The health officials wish to determine the cause of the epidemic. They question the patients, being guided in their questions by previously established knowledge of the usual causes of typhoid. It soon appears that all of the sufferers had eaten oysters, while there seems to be no other common feature to the various cases that could possibly have occasioned the disease. Accordingly, strong confirmation is secured that eating of oysters was the cause of the disease. So far, of course, this procedure exemplifies the principle of agreement only. A regular connection appears to be established between the occurrence of the typhoid and a recent meal of oysters. But there may have been some other cause, unhypothesized and unnoticed, that happened to be present in each of the cases where oysters had been eaten, and was the real cause, or at least coöperated with typhoid-infected oysters as an additional cause. To reduce to the minimum this possibility it is necessary to compare the cases so far studied with cases similar in other respects, but in which oysters were not eaten. If none of these cases have developed typhoid, then the possibility becomes very remote that anything other than the eating of oysters has operated as a cause. We wish, in other words, to get hold of a single and unambiguous cause for this challenging effect, and it is clear that if we discover typhoid cases where oysters had not been eaten, the oysters were at least not the only cause, whereas if no such cases appear the probability will rise almost to certainty that the oysters alone

were responsible for the epidemic. We want to be able to say: Given typhoid, then eating of oysters from a certain supply; given the eating of oysters from such a source, then typhoid fever. And just as it is important in applying the principle of agreement to study cases as varied as possible in other respects so long as they agree in the particular respect whose connection is being studied, so in the joint method it is important to compare the whole group with another group as similar as possible in every respect except the particular respect whose connection is studied. Including this point in the statement of our guiding principle, we may reformulate it as follows: *No two facts are universally connected if one may be absent when the other is present, and the certainty of the connection increases as we fail to find cases of the nonoccurrence of one, similar in other respects to cases of its occurrence, where the other is present.* Thus abstractly stated, this combined principle of agreement and difference is perhaps difficult to grasp clearly. Let us apply it to our illustration.

The health officers, not satisfied with the discovery that the typhoid sufferers had all eaten oysters, investigated the other members of the stricken families. They found that in family A two members had not come down with the disease. Neither had eaten the oysters, yet in other matters their living conditions were the same as those of the sick members. They had eaten the same other food, used the same drinking water, the same milk supply, etc. Hence none of these other matters could be the cause of the disease. Similar results were secured in family B. Here three members were not sick. Two of them had eaten no oysters; the other had eaten a taste or two only. After continuing the examination, with the same outcome, among a number of families, the health department pronounced the oysters to be the cause of the disease with a confidence and certainty that could not have been secured by the method of agreement alone. That could make it highly probable that the oysters were a cause of the disease. We know now by the joint method that the possibility is exceedingly remote that anything but the oysters was a cause of the disease.

Symbolic representation of the result

The results of this method of investigation may be symbolized as follows:

Cases where the typhoid was present.

| Patient | | |
|---|---|---|
| 1 | abcd | d is present in all cases and by the principle of agreement is indicated as a cause of the disease. |
| 2 | edfg | |
| 3 | hidj | |
| 4 | dklm | |
| 5 | ndop | |
| etc. | | |

Cases where the typhoid was not present.

| Case | | |
|---|---|---|
| 1 | eblp | d is absent in all these cases, although any of the other factors sometimes associated with it in cases of typhoid may be present. By applying also the principle of difference in this way the possibility that some other factor is regularly connected with typhoid is ruled out. |
| 2 | onfc | |
| 3 | hgak | |
| 4 | mipj | |
| etc. | | |

What concrete facts do these symbols stand for in this case? Well, d, of course, stands for oysters eaten; a, milk from Mr. Z.'s dairy; b, drinking water from the well; c, vegetables from peddler; e, milk from dairy Y; f, meat eaten that might have been spoiled; g, drinking-water from reservoir; h, cream bought from neighbor S.; i, use water from river; j, just recovering from a case of measles; k, use milk from cows; l, pork eaten heartily the day before the disease appeared; m, swampy ground near house; n, use vegetables from own farm; o, use canned milk; p, all groceries bought from corner store. In short, of the various factors that in our present knowledge of typhoid might be connected with the epidemic, the only one which was constantly present in cases where the disease occurred was the eating of oysters, and while the latter was constantly absent in cases where the disease did not occur, each of the other factors was in at least some of them present. Our assurance in the result reached is thus very strong, when compared with that obtainable through the principle of agreement only. We not only know that cases of the disease in this epidemic are regu-

larly connected with the eating of oysters, but also that they are not regularly connected with any other possible cause. Given d, then typhoid; given non-d, then non-typhoid.

Of course, now that medical science has reached the point where the typhoid bacillus has been isolated and identified, such an investigation would be greatly shortened. As soon as questioning of a few cases had revealed the fact that oysters had been eaten, oysters from the same stock would be secured and subjected to laboratory test. The appearance of the bacilli would then solve the problem at once, and steps could be taken without delay to trace the source of that particular stock and prevent further spread of the epidemic. This method of laboratory experiment will soon be considered.

Illustration fro the history of science

The observational use of the joint method in the history of science may be illustrated by Liebig's investigation of the manner in which certain acids and salts, such as those of lead, bismuth, copper, and mercury, destroy life when introduced into an animal organism.[1] Liebig first placed solutions of these various substances in contact with various types of animal tissue (muscular fiber, membranes, etc.) and also animal products such as albumen and milk. He observed that in each case, whatever the variation of other factors, the acid or salt left the water in which it had been dissolved and entered with the animal substance into a chemical compound which resisted the action of the ordinary causes of decomposition. Since organic life consists in a continual decomposition and recomposition of the organs and tissues, anything that incapacitates them for such processes destroys life. Thus Liebig was able to establish on strong evidence, by the method of agreement, the theory that the proximate cause of death as produced by such poisons, was the union of the salt with the animal substance to form compounds undecomposable by organic action.

But it was very desirable to supplement this inquiry by a study of cases as similar to these as possible which did not result in death. Liebig found these by using the so-called antidotes to these poisons. He observed that when these were

[1] Mill, J. S., *A System of Logic*, p.

present the acid or salt of the poison formed an insoluble compound with the antidote, which, because it was insoluble, could not act at all on animal tissues. Peroxide of iron thus combined with arsenic acid, sugar with salts of copper, and sulphuric acid with salts of lead. Moreover, as still further confirmation of his theory, Liebig was able to show that the reason nitrate of silver is harmless when taken internally is that there is always in the digestive tract a certain quantity of common salt and free muriatic acid, both of which substances combine with the nitrate, and if its quantity is not too great convert it into chloride of silver, which is incapable of combining with the organic tissues. By expanding the method of agreement into the joint method, Liebig thus established his theory on a much more exact foundation.

We see thus again in a case of important scientific achievement in just what way the joint method supplements the method of agreement. The latter method may reveal a high probability that A is universally connected with B. The former defines the connection more closely and gives fuller control by showing it highly probable that A is not connected with any alternative to B.

What weaknesses are present in this observational procedure of scientific verification?

Weaknesses in the observational application of the principles

Well, it is evident for one thing that the possibility of hasty generalization is not entirely eliminated, and we wonder whether some change in our method might not be found which would reduce it still more to a minimum. The connection thus established may not hold in every case, under other circumstances than those in which we have so far studied it. Putting the matter in terms of the comparison of affirmative with negative instances, which is the chief strength of the joint method, it is still possible that there was some quite unnoticed factor —a constant attendant of the supposed cause when it is present and constantly absent when it is absent—that in the course of a more complete investigation would be shown to be the real cause rather than the one which seemed verified by the inquiry to date. Or it may have coöperated with it as a joint cause.

In one noticeable form this has often been the case in the history of science. Often a certain event has been regarded for a while as regularly connected with another, when in reality it was only some minute factor within that event that was so regularly connected. Swampy air, for example, was long regarded as the cause of malaria, whereas later investigation showed that the real cause was the mosquitoes which bred in the swamps.

The joint method may, in other words, when used in the manner just described, result in setting up laws of connection between things only very crudely and meagerly analyzed, whereas more exact analysis may reveal needed correction, connecting one with some previously unnoticed part of the other. Our typhoid illustration will bring out the practical importance of this. Did such an epidemic happen in a community which had just begun to use oysters, the method above described might lead to a permanent taboo on the eating of oysters, whereas, of course, it is only typhoid-infected oysters that need to be avoided. Further comparison and study, by a method that does not take events and their relations merely in bulk, so to speak, but proceeds to dissect them and note the functions of their parts by subjecting them to artificial conditions, is the only way in which universal laws can be established between cases of typhoid fever and such minute, hidden entities as typhoid bacilli. We need, accordingly, a way of applying the principles of agreement and difference, which, where possible, will secure this more exact type of analysis and give us still greater confidence that the connections reached are without exception.

It is this need which has expressed itself in the history of science in the development of methods and tools of active experimentation, and the building of structures which are termed laboratories.

Here we pass from modes of verification which do not necessarily involve more than the systematic observation, with no special tools to aid us, of what is happening in the world quite apart from our interference, with modes which do depend upon

our interference and which rapidly plunge us into the necessity of inventing tools to do what our unaided muscles and senses cannot do. If we wish to use the term experiment in a very broad sense, we may say, of course, that critical observation is itself a form of experimental analysis; yet there is a great difference between a situation in which we are simply watching carefully what Nature is doing for us, and a situation in which we are actively manipulating things so as to force her to engage in performances which, apart from such manipulation, would rarely occur, if ever. Whatever primitive thinker it was who first experimented in this narrower and more proper sense of the term when attempting to verify a hypothesized law, was taking an epochal step in the history of science. Every branch of knowledge moves by leaps and bounds to hitherto undreamed-of achievement as soon as it becomes possible to introduce active experimentation into its work in a systematic way. In the main, scientific experimentation is an affair of the modern world, and it is this fact more than any other that accounts for the significant difference between the scientific achievements of ancient and those of modern times. Except for an occasional student of mechanics, like Archimedes, and a few physicians like Hippocrates, there was nothing at all in the way of scientific experiment practiced in the ancient world, and the former at least, even of these two, was rather ashamed of such activities as being beneath the dignity of a Greek gentleman. It was the sciences of pure thought, such as formal logic, or of observation such as astronomy, or of the union of the two under the control of the former, such as geometry, that alone attained success and influence in ancient times. As the philosopher Kant remarks:

**Experimental manipulation of nature**

> When Galileo let balls of a particular weight, which he had determined himself, roll down an inclined plain, or Torricelli made the air carry a weight, which he had previously determined to be equal to a definite volume of water; or when, in later times, Stahl changed metal into lime, and lime again into metals, by withdrawing and restoring something, a new light flashed on all students of nature. They comprehended that reason has insight into that only, which she herself produces on her own plan, and that she must move forward with the principles of her judgments, according to fixed

law, and compel nature to answer her questions, but not let herself be led by nature, as it were in leading-strings, because otherwise accidental observations, made on no previously fixed plan, will never converge towards a necessary law, which is the only thing that reason seeks and requires. Reason, holding in one hand its principles, according to which concordant phenomena alone can be admitted as laws of nature, and in the other hand the experiment, which it has devised according to those principles, must approach nature, in order to be taught by it, but not in the character of a pupil, who agrees to everything the master likes, but as an appointed judge, who compels the witnesses to answer the questions which he himself proposes.[1]

Experiment involves no new assumption

Now experimental analysis does not imply any new rule or guiding principle beyond those stated in the preceding chapter. What it does introduce is an artificial control of the conditions affecting events, so that they or the parts into which they have been dissected may be added or eliminated one by one, enabling us to observe precisely what the concomitants of each are, and with much less likelihood that factors which we did not notice or desire were modifying the result of our calculations. Furthermore, the use of this method encourages and enables us to analyze more and more minutely the phenomena with which we are dealing, thus gradually reducing the heterogeneous laws that we at first set up as a result of our thinking, to deductions, under special conditions, of simpler and more general laws expressing the relations of their component parts. In this respect the method of experimental analysis points forward to the still more exact and inclusive procedure which will be studied in the next chapter.

It may establish one-many or reversible relations

It is to be noted that this controlled manipulation of conditions so as to determine the precise concomitants of each taken alone, may be used either in such a manner as to establish one-many connections of events, or in such a manner as to verify what we have called reversible relations, depending upon whether one or both factors involved are subject to laboratory control. If we merely introduce or eliminate A, holding other conditions constant, and note whether B appears in the former case and disappears in the latter, our experiment, if successful, will

[1] *Critique of Pure Reason*, Max Mueller translation, 1907 ed., p. 691. By permission of The Macmillan Company.

establish a one-many relation only. For we do not know whether, under conditions outside of our experiment, B may not sometimes appear without A. If in addition to this we experiment upon B, and find that A behaves as B did in the former case, then we may establish a reversible relation.

A simple illustrative experiment

Let us examine a few instances of experimental analysis in the strict sense, beginning with a simple experiment, without any special apparatus, that anybody might use in daily life. Suppose that, after you have put on your shoes some morning, and have begun to walk on them, you feel the pressure of some sharp substance against one of your feet. Is it a pebble, or a protruding nail? (The reason you limit your consideration to these two alternatives, at first, is, of course, that previous unpleasant experiences of the same sort have always been found due to one or the other of these two causes.) Accordingly, you devise a simple experiment to decide between these alternatives. You take the shoe off, turn it upside down, and shake it. If a pebble rolls out, and on putting the shoe on again the painful pressure has disappeared, you conclude that the pebble was the cause of the discomfort. So far as you can see, all other relevant conditions have remained the same except the presence of the pebble; hence, since the pressure is now gone it must have been due to the one attendant condition that is now gone. Should, on the other hand, the result of the experiment be negative—that is, should no pebble roll out of the shoe—you would proceed with another experiment designed to test the other alternative. You would feel over the inside of the shoe carefully to see if a nail could be located. If you find one, and on pounding it down with a hammer the pressure ceases, again you are confident that the true explanation has been secured. Should it be impossible to verify either of these two alternatives, then you would be brought back to step two of your problem, and would try to clarify it further by trial and error manipulation until some other suggestion appeared plausible. This means, in the terms used above, that you would analyze the interior of the shoe more thoroughly than you would have had occasion to analyze it before, in the effort to discover some previously unsuspected

factor that might be verified as the real cause of the pressure. In this case it might prove to be a thick joint in the seam that had worn through the lining, or a warp in the leather. But in any case your manipulations would have involved an analysis of the structure of the shoe into parts that you had not previously noticed, and would have led to the forming and testing of hypotheses about the relations of those parts which would never have been considered apart from the use of such experimentation. Thus, even in this simple form drawn from daily experience, experiment reveals all the important logical qualities that the more refined experiments of the laboratory, with all the precision secured by artificial instruments, can ever reveal.

**Examples of scientific experiment**

Let us now examine two relatively simple scientific experiments. In 1862, Sachs was led to the hypothesis that starch was formed by the influence of light in decomposing the carbon-dioxide gas in chlorophyll. He accordingly devised an experiment in which, while all other conditions remained constant as far as he could tell, light might be either admitted or excluded from a plant. The result of the experiment was that when light was excluded no starch was formed; the single circumstance of readmitting light, however, was followed by the renewed formation of starch. To increase even the certainty which this experiment seemed to justify, he covered certain portions of the leaves of an otherwise illuminated plant with pieces of black paper. No starch was found in these portions, whereas it continued to be formed in the others. Here again the assumption underlying the experiment is quite clear. Keeping other conditions the same, introduce or eliminate a specific factor. The other differences which accompany this single change are thereby shown to be connected with it according to a universal law. In 1668 Francesco Redi arranged an experiment to test the common belief of naturalists that in some forms life is spontaneously generated, the appearance of maggots in decaying meat being often cited in evidence. The experiment consisted in exposing meat in several jars, all being prepared under the same conditions except that some of the jars were left uncovered, some were covered with parchment, and others with wire gauze. The

meat in all the vessels became spoiled and flies were attracted by the smell of the decaying meat. In the uncovered jars a large crop of maggots appeared, while none at all appeared in the others. In the case of the jars covered with wire netting, however, flies had laid eggs on the netting, and when they hatched maggots appeared on the surface of the wire gauze. Redi's conclusion from the experiment was that maggots arise in decaying meat, not spontaneously, but from the hatching of the eggs of insects.

**A more complex experiment, using technical instruments**

We may now add to these a more complex experiment, whose outcome, along with that of other experiments in electro-magnetics, has upset the foundations of Newtonian dynamics and led to the contemporary speculations of the theory of relativity. This is the famous Michelson-Morley experiment of 1883. The purpose of this experiment was to calculate the absolute velocity of a point on the surface of the earth—that is, in accordance with the assumptions of the time, its velocity through the ether—in terms of the velocity of light. Selecting a point S, the experimenters measured off a distance l parallel to the direction of motion of S in the earth's orbit around the sun, and placed at that distance a mirror $M_1$, normally to the line from S. The same distance l was also measured off from S in a direction perpendicular to that from S to $M_1$, and a second mirror $M_2$ was placed at this distance normally to its line. The arrangement is shown in the accompanying figure.

Now at a certain moment the experimenters sent out a flash of light from S to the two mirrors $M_1$ and $M_2$. What they expected to discover is shown by the following calculations. We ask,

what will be the time, first, that it will take for the beam of light to reach $M_1$ and be reflected back to S? Obviously, to reach $M_1$, the light will have to cover a greater distance than l, for $M_1$ is moving in the direction of the arrow at the velocity v while the light is coming from S. Similarly, in its return it will have to travel a smaller distance than l, for S will be coming to meet it at the velocity v. Let $t_1$ be the time needed for the beam of light to make the trip to $M_1$ and return. By computation we can show then that $t_1 = \frac{2lc}{c^2 - v^2}$, where c represents the velocity of light. What, now, about the beam which goes to $M_2$? Its path is represented by the following diagram. Since both S and $M_2$ are moving in the direction of the arrow at the velocity v, by the time the beam has reached $M_2$ they have moved to the positions S′ and $M'_2$, and by the time the beam has been reflected back to S again they have reached the positions S″ and $M_2''$. The actual course of the beam of light is thus S—M′—S.″ Calculating $t_2$ on this basis, we find it equal to $\frac{2l}{\sqrt{c^2 - v^2}}$. Thus $t_2$ is measurably different from $t_1$—that is, the two beams of light do not get back to the source at the same time. If, now, we have any independent method of measuring the difference between them, we shall be able to state one in terms of the other, and that in turn will enable us to calculate v in terms of c, which was the original problem. Such an independent method of measuring the difference between $t_1$ and $t_2$ the investigators had prepared in the form of an interferometer delicate enough to determine the shift in the position of the interference bands which always arises when two beams of light which have traveled by different paths

from the same source meet again. The assumption once more is that when other conditions remain constant, the difference which appears from an experimentally determined difference is connected with it according to a universal law. The significant and epochal result of the experiment was that no shifting of the interference bands appeared at all. And since the experiment had been conceived and guided in terms of the fundamental assumptions of traditional dynamics about time, space, matter, and light, an essential inadequacy in these assumptions was thus revealed. It became necessary for physicists to speculate anew on the very foundations of their science in order to create a set of conceptions such as would be consistent with all that had been experimentally established in the old dynamics as well as with the results of the new experiments.

**Value of such experimental analysis**

In the light of these illustrations let us consider again in what definite ways this method of experimental analysis gives us an advance over the procedures earlier discussed. On the one hand, it is better than mere observation, however carefully conducted, in that it forces Nature to reveal her secrets without our having to wait till she spontaneously produces the conditions we seek to study. Many such conditions occur very rarely without our interference; some would not occur at all within an ordinary investigator's lifetime; and many, though occurring spontaneously, would not do so in ways that we could analyze and measure precisely had not the success and value of simple experiments led us to embark on the invention and perfecting of instruments which make it possible to study and measure details more and more minute as compared with what the senses alone are able to note. The interferometer, whose present high degree of perfection we owe to Professor Michelson, is a striking illustration of this point. Behind its very possibility lie centuries of increasingly complex experimental procedure, marked by a growing sense of the value of instrumental aids to experiment. It would be possible, as earlier suggested, to write a history of experimental science in terms of the invention and perfecting of instruments to supplement the senses and muscles in carrying on observations and con-

trolled experiments, beginning with the telescope of Galileo and his contemporaries, which first stimulated the imagination to glimpse the possibilities of such inventions, down through the various -scopes, -meters, and -stats, to the most complex and delicate machines that a well-equipped scientific laboratory at the present time will possess.

The function of laboratories

The function of scientific laboratories, such as now form part of the equipment of every important institution of learning, is precisely to house these expensive and delicate instruments, and to provide controlled conditions of their application where the problem is such that no considerable space is required for the indicated experiments. In our generation for the first time the psychological and social sciences are establishing laboratories, in the attempt to furnish, in their fields, wherever possible, conditions favoring exact and objectively demonstrable experimental research.

Experiment reduces hasty generalization to a minimum

On the other hand, the method of controlled experiment, by varying one distinguishable factor at a time while holding other conditions constant, gives us a degree of assurance otherwise impossible that there is no hidden accompaniment of our apparently verified relation that is really responsible for the occurrence of the event we are primarily studying. It thus gives us the best warrant that science has so far been able to secure that we are not falling into the fallacy of hasty generalization through the possibility of an unresolved plurality of points of agreement or points of difference. The ways of generalization previously discussed, when used without the aid of controlled experiment, could only give us the assurance that no such plurality seemed to be present in the occurrence of the relation in a wide variety of cases, also perhaps as compared with a group of similar cases in which neither term of the relation was present. The method of experiment is actively to introduce a single factor into a field otherwise kept constant under laboratory conditions, and see what happens then that was not happening before the factor had been introduced; or to eliminate a factor and note what other factors disappear with it. It is clear that such resulting changes cannot be connected with factors which

remain constant during them; we are forced, therefore, to hold that they are necessarily connected with the one change on which they follow. And if early experiments on any problem are ambiguous, we proceed to analyze the situation still more minutely, and rearrange the experiment so as to test part by part of the ambiguous factor, till we reach some part which proves to be regularly connected with the event we are trying to explain.

A crucial experiment

Because of these characteristics of the experimental method it is possible by its use to establish a universal law by a single decisive experiment—a *crucial* experiment in the terminology of early modern science. Suppose that as a result of preliminary observation the theory has been strongly indicated that N is universally connected with P, so that given N, P will follow, and on the elimination of N, P will disappear. If conditions are within our control, a single decisive experiment can complete the verification as satisfactorily as a larger number of experiments could do. Arrange a situation such that, while every other factor remains as it was, N, and only N, is introduced, and see if P follows. Then arrange it so as to eliminate N, while every other factor remains the same, and see if P disappears. If such an experiment clearly confirms the theory, it may then be affirmed without hesitation as a universal law. This use of the crucial experiment suggests a consideration that may be helpfully introduced at this point.

In the ordinary procedure of experimental science as now developed, what is the practical relation between the merely observational use of the principles of agreement and difference, and their active experimental use in guiding decisive experiments such as the Michelson-Morley experiment recently described? How in general do observation and experiment actually cooperate? In most investigations in exact science at the present time, the observational application of the principles occurs mainly in the second step of the scientist's attack upon his problem. It clarifies the data and gives rise to a number of suggestions already supported by a number of instances. The fifth step itself will usually consist in some such decisive ex-

periment as has just been portrayed, resulting either in the definite verification of the hypothesis or in the demonstration of a definite inadequacy in it, which leads to the formation of another hypothesis to be tested, if possible, by a second experiment. This relation between observation and experiment will be illustrated in the next chapter. Active experiment, where available, is *par excellence* the method of empirical verification —observation plays the subsidiary rôle of clarification, giving rise to probable suggestions.

**Inadequacies of the procedures thus far analyzed**

What, now, do we want an experimental method to do that even this procedure of laboratory control does not always do? In the gradual advance of the demands and possibilities of scientific knowledge, chiefly two things become desirable that will not necessarily be secured by this technique.

In the first place, there are many factors whose regular connections it is highly important for us to study under the exact conditions of experimental control, which can never be eliminated entirely. The gravitational attraction of the earth, the light and heat of the sun, the presence of the atmosphere and of the constituents of the earth's surface, may illustrate this. Some of these may, of course, be reduced much below their normal proportions, but cannot be completely eliminated. We need a way of establishing dependable laws about the behavior of these things, with the rigor secured by genuine experimental control, even if we cannot introduce nor eliminate them and find out what would happen in their complete absence.

**In particular, need of quantitative formulation**

In the second place, we need a method that will lead to the unification of scientific laws in a quantitative system. The procedures so far discussed do not necessarily do this. As their result a law of connection may be simply established between two qualities or events that will not fit into an organic system with other laws at all. Science might thus take the form of a collection of heterogeneous relations which would give separate laws about the facts they relate, but form no larger unity—and we saw in chapter three that primitive knowledge doubtless did exist for many centuries in just this form

(though of course without the certainty that careful experimental control would have furnished). Now science cannot offer much satisfaction to either our practical or theoretical needs till it becomes systematic, at least not till large areas of it have been unified in terms of a few fundamental laws from which all other laws applicable within that area are corollaries under specific conditions. This is highly important theoretically because our theoretical desire is to understand the world, or some large field of it, as a whole; unless we can find certain laws that are present in everything that happens within that field, and thus bind together the more limited and particular laws, our intellectual grasp is denied, our rational curiosity thwarted. It is important practically because the number of unrelated specific laws that we can hold together in mind is very limited. Unless we can think of them as simply the meaning, under special circumstances, of a few very general laws that can be easily remembered, it is much more difficult to recall the proper principle to apply on the occasion which demands it. The underlying, inclusive law, when discovered, expands the area of our intellectual grasp, and gives a new sense of security to our dependence on the particular law which we view as one of its corollaries. Then the principle we are applying does not, so to speak, stand on its own feet merely; behind it is the warrant, not only of the data on which it directly rests, but also the data on which all the other special laws rest which together with it are embraced by the general law. Much more, in other words, that we have scientific confidence in must also be untrue if it fails to hold. This point will become clear if we consider, for example, the difference in our understanding and control of the material world between knowing a number of specific relations, such as that unsupported objects fall to the ground, that certain gases rise, that the planets move in elliptical orbits, etc., and knowing an inclusive generalization such as the law of gravitation, from which these and many others can be systematically deduced when we are given the special character of the bodies to which they refer.

Mathematical formulation the answer to this need

Now the way which exact science has hit upon historically to secure this unification is to analyze what happens into smaller units so selected as to be common constituents in a vast variety and complexity of events, and constituents moreover of such a sort that these more complex happenings in all their variety and difference can be regarded as groupings of these common units after a quantitative pattern. This means that in any field in which such an analysis is successfully made, every verified law of connection between gross qualitative substances or events becomes viewed as a specific consequence of a few more general laws expressing the behavior of these common units. Any complex event being thus regarded as a quantitative combination of the simpler units, all exact laws become reducible to mathematical form, gaining thus the objectivity and precision of a quantitative statement in symbolic language, as well as a common foundation with all other laws applying in the same field.

It is easy to see that the conceptions of cause and effect become almost obsolete wherever science has advanced to the point of successfully picking out these quantitative units in any given process of change. The events that had previously been called cause and effect, in other words, become conceived now as themselves in constant change, and the universal relation between them becomes an expression, under special conditions, of the more general laws of change that are constantly revealed in the endless rearrangements of their internal parts. The reason is thus evident for the statement made earlier that dependence on causal explanations is the mark of a relatively early stage in the development of a science, the stage at which this profounder analysis has not yet been successfully made.

Relation between such analysis and common-sense explanations

It is further important to observe that with the introduction of this method of quantitative analysis on a broad scale, we appear for the first time to introduce a noticeable gap between the assumptions of common-sense verification and those of scientific procedure, and it is the sense of this gap that in large part explains what popular distrust of science still exists. By its reduction of our sense world into a complex of minute, invisible units, physical science seems to replace the realm observed by

the common man by a quite different, unfamiliar, even mysterious world. The statement that the sun warms, as verified by common experience, gives nobody trouble; in confirming it we know precisely what facts of life the terms used refer to, and our thinking is implicitly controlled by the same principles as the scientist appears to be using in the examples of his work so far cited. But if we substitute for this simple statement one in terms of the correlation between the play of certain ether waves upon the surface of the body and an increased rapidity of the motion of the molecules of the latter, many people feel themselves transported into another realm which has quite left behind the familiar facts with which we began.

The reader will see, however, that this gap is apparent rather than real. Even common sense analyzes in its explanations, picking out facts to be related that would otherwise remain unnoticed, as the experiment with the shoe indicates. A thoroughgoing quantitative analysis of the experienced world but carries forward this analysis in a more minute and systematic way, and gives it the form that is most fruitful for exact understanding and control.

Summary

But it is obvious that if this is the manner in which we are to seek the necessary unity of science, we must so apply our observation and experiments as to take for granted this quantitative reduction, and lead to the formulation in quantitative terms of the laws of connection which result. The gradual realization of this need has led to the adoption, where possible, of a more inclusive and satisfactory technique, in which all other scientific procedures merge, and in which they find, so far as we can judge at present, their culmination. This we shall term the method of functional analysis.

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## CHAPTER ELEVEN

# THE METHOD OF FUNCTIONAL ANALYSIS

The term function

WHAT is a function?

In the sense in which science uses the term, and in which we may appropriately speak of a functional explanation, it has two meanings. For one thing, it means the normal or characteristic activity of any distinguishable entity, as when we speak of the function of a lever, of the lungs, of a public official. With this meaning we are not especially concerned in inductive logic. The other meaning, with which we are directly concerned, must also be distinguished into a broader and a more limited connotation, the common idea in both of them being that of a regular relation between two or more processes of change. Let us examine these meanings rather carefully.

Vague and mathematical functions

In the broader sense, a function may be defined as any fact so related to another that it varies in some determinate way with that other. Either may then be called a function of the other, which means that for every distinguishable change in the one there corresponds a distinguishable change in the other. Thus we may say that the general health of a person is a function of his digestion, that the crops of a given region are a function of its soil and climate, or that the duties of Congress are a function of the Constitution.

But it is evident that such statements carry little exactitude, and that they no more help to bring about the unification of scientific knowledge than the methods of formulation previously noted. To achieve these results, as has just been shown, we must analyze each of the related processes into quantitative units, and express the relation between them as a relation of variable magnitudes. This gives us mathematical precision in our state-

ments of scientific law, and also offers a basis for uniting in a single system of exact knowledge all processes which are analyzable in terms of the same type of unit. The laws of behavior of these units thus become the general laws pervading the entire field so united. In other words, we turn from this broader conception of function to a more limited but far more fruitful conception, that of mathematical function. It is functional explanations of this sort that are increasingly seen to mark the maturity of exact science.

A few definitions

First we must define a few basic terms. A *mathematical function* is a variable magnitude so related to another magnitude that for every value of the latter there is a corresponding value of the former. By *value,* of course, is meant any determinate quantity of such a magnitude. Either magnitude may be spoken of as a function of the other, but since in any given statement of their relation one must be arbitrarily regarded as primary and the other spoken of as its function, it is necessary to draw a distinction between independent and dependent variables. The *independent variable* is that magnitude which in the statement in question is regarded as given, or is arbitrarily assigned. The other magnitude or magnitudes, which are regarded as functions of it, are *dependent variables.* Thus we may say that the surface and volume of a sphere are functions of its radius. This means that for any value of the radius, say nine inches, there correspond definite values for the surface and volume, respectively, expressed in square or cubic inches. When stated in this form the radius is the independent variable, since it is taken arbitrarily as given, and the surface and volume, being affirmed to be functions of the radius, are dependent variables. It would be just as correct to convert the law and say that the radius is a function of the surface or of the volume. In this case the radius would be a dependent variable, and whichever of the other two were taken as given would become the independent variable.

In such relations as these there is only one independent variable, since a determinate value for it is all that is needed to determine completely the values of the others. Sometimes there must be more than one independent variable in order that def-

inite values for the dependent variables may be indicated. Thus we may note that the density of a gas is a function of its volume and its pressure. This means that definite values must be assigned to both the latter quantities in order to determine a corresponding value of the former. Here the density is the dependent variable, and the volume and pressure are both independent variables.

Let us now consider a few illustrations of this method of functional analysis, advancing from more popular and less precise to more technical investigations, while noting in each case the essential features of the explanation reached. We shall find that the simpler cases will reveal the characteristics which Mill assigned to what he called the Method of Concomitant Variations, a term which is here rejected in favor of the broader and more precise conception of function.[1]

Illustration from common life

Suppose a housewife notices that every once in a while her family eats more for dinner than usual. After considering various explanations she recollects that a number of those occasions were ones on which the dinner had been somewhat delayed. She accordingly formulates the hypothesis that the amount consumed is a function of the time at which the dinner is served. If, in comparing the experiences she has noted, it proves possible to correlate an added increment of food with every added increment of time, she will have established, though of course only in a rough and loose fashion, the functional relation hypothesized between the two. Observe that the result as thus expressed gives considerably more information than the mere statement of a regular connection between delay and larger consumption. An exact parallel between the quantitative variations of each is also affirmed, making possible a form of guidance in the future which would otherwise be impossible. Of course, in this case, the measurements are probably inaccurate, and the unit of food used could hardly be precisely defined. These deficiencies would need to be remedied before science could make much use of the results reached, and in that case it would doubt-

[1] Mill's remaining method, that of Residues, is really a form of deductive thinking. Its principle is that of the disjunctive syllogism.

less appear that the phenomenon studied was dependent upon other independent variables as well, such as the kind of food served and the family's occupations during the afternoon.

**From a popular economic discussion**

A popular illustration revealing more of the important factors in this type of explanation is the following. A group of friends fall into a discussion of the varying standards of living of different families. What is the explanation? The suggestion would not long be lacking that the size of the income enjoyed by a family is the main conditioning factor, that, in other words, a family's standard of living is a function of its income. Before this suggestion could be tested, however, it would be necessary to analyze what is meant by standard of living in terms of some quantitative unit or scale. It is agreed, let us say, that this is to be done by drawing up a scale of the main commodities enjoyed by people, proceeding from bare necessaries at one end to rare luxuries at the other, and assuming that all steps of advance or decline on this scale are equal quantitatively. If, then, all the available data indicate that for every advance in family income there is a proportionate advance in the position of the family on this scale, and for every decline in income a proportionate decline on the scale, the hypothesis could be set up as so far a verified law.

Now here is the same lack of the desired precision in one of the units of measurement involved, that of the standard of living, but the field within which the relation holds and has significance becomes somewhat clearer than it was in the previous illustration. Our distraction due to the possible presence of other independent variables, at least within limits, is not so great, and we may find a brief phrase which will fairly describe the field pervaded by the relation, namely the economic life of the family. In so far as the units of income and of normal family wants can be stated in precise form and their laws of relation formulated, we are in a position to give a similar functional explanation in terms of these laws to every problem falling within this field. But with that we should have reached a more extensive exact science than has yet proved possible in these matters. In any event, it is clear again that a functional explanation, even

where the unit of measurement is vague, establishes a more complete relation between the facts examined than is established by the preceding methods.

Illustration from Pasteur's investigations

We pass by gradual steps from these vague and poorly controlled functional relations to those which reveal a greater measure of mathematical exactitude and laboratory control. Consider one of Pasteur's experiments on the source of the microorganisms appearing in liquids which had been thoroughly sterilized. Having formed, by other investigations, the hypothesis that the source of these organisms was in the atmosphere, he prepared an experiment designed to show whether their appearance was a function of the presence of atmospheric dusts. He "took a series of bulbs of about a quarter of a litre in capacity, and after having half filled them with a putrescible liquid, he drew out the necks by means of the blowpipe, then caused the liquid to boil for some minutes, and during the ebullition, while the steam issued from the tapering ends of the bulbs, he sealed them with the lamp. Thus prepared, the bulbs were easily transported. As they were empty of air . . . when the sealed end was broken off, the air rushed into the tube, carrying with it all the germs it held in suspension. Closing the tube immediately afterwards with a flame, and leaving the vessels to themselves, it was easy to recognize those in which a change occurred. Pasteur opened and resealed twenty of these bulbs in the country, far from all habitations; twenty more in the Jura, at 850 meters above sea-level; and twenty more in the Montanvert, at 2,000 meters. In the first twenty there were eight bulbs in which organisms appeared; in the second twenty there were five; in the third twenty, only one."[1] Pasteur had previously shown that when air was admitted to sterilized liquids near the city streets, microörganisms would appear in all the bulbs. He regarded the experiment as clear confirmation of his theory that the appearance of the organisms was a function of the presence of atmospheric dust—that is, that they were carried around on

[1] Creighton, J. E. *An Introductory Logic*, p. 475 (copyright 1920). By permission of The Macmillan Company.

the dusts of the air. Considered as an attempt to establish an exact mathematical function between these two variables, Pasteur's experiment reveals the defect that there was no exact statement of the quantity of dust per cubic foot in the atmosphere in the various places where he opened the bulbs. Had such data been used, and the correspondence been exact, it would have been possible to state the result with the precision of a mathematical formula. Pasteur's purpose, however, did not involve such an attempt. He was satisfied to show that the micro-organisms were not spontaneously generated, that they appeared wherever there was contact with the dusts of the air, and that, therefore, to avoid them, it was necessary to exclude the atmospheric dusts. His work and that of others who followed him made it possible to guard intelligently against infection with the various germicides and antiseptic treatments that are now available.

From Kepler's investigation of planetary motion

An instance that comes still closer to the mathematical completeness just suggested is found in Kepler's astronomical studies. Kepler's main purpose was to discover underlying mathematical harmonies in the relations of the celestial bodies, which he was certain must be discoverable as verifications of the Copernican hypothesis. Among such harmonies he thought that there must be a regular law connecting the velocities of the planets with their distances from the sun. His first suggestions proved unverifiable, being attempts to connect the time of revolution with the distance covered in the planet's orbit. Finally he made the happy guess that the time was proportionate to the area swept out by the planet-vector. Testing this by the very careful observations left him by the Danish astronomer Tycho Brahe, he verified the law that one of these variables was a direct function of the other. Moreover, by stating the law in this form, Kepler pointed the way toward the fuller synthesis of Newton, who proved that both of these variables were dependent on the mass of the planet in its relation to the mass of the sun, and whose behavior was thus a corollary of the all-embracing law of gravitation.

From Joule's establishment of the mechanical equivalent of heat

As we see from this illustration, it is necessary, if we wish to see the full possibilities of this method of functional analysis, to turn to those sciences that have already become exact in the true sense of the word—sciences which have succeeded in isolating their field, defining their units unambiguously, and stating the basic mathematical laws that hold throughout that field. So far, certain branches of physical science only, of which mechanics is the best known example, seem to instance sciences which have been able to reach this point except the purely formal science of mathematics itself. We shall accordingly give one more illustration from the field of mechanics, which will exemplify this method of functional analysis at its best.

J. P. Joule it was who first placed the kinetic theory of heat on a sound experimental basis. Before him the theory that heat was increased molecular motion within a body had been suggested, but no way had been devised of carrying out the detailed experiments necessary to verify it. In fact, it was first necessary to study the motion of molecules of gases with thoroughness before the kinetic theory of heat could be stated in quantitative terms of such a sort that experiments adequate to test it could be set up. But this point having been reached, Joule

> . . . elaborated the consequences of that theory, and then actually discovered by physical measurements in his laboratory that those consequences did take place. If heat is not a fluid, but is rather the energy of molecular motion within a body, and if those molecular movements take place in accordance with the ordinary mechanical laws of motion, then, when mechanical energy is expended upon a body, say through pressure upon a gas, and is transformed into heat, or the increased motion of the molecules within that body, the energy which disappeared in the act of compression should exactly equal the energy which appears in the increased motion of the molecules, or heat. Conversely, the energy of molecular motion which disappears when a gas expands again (or the heat which it loses on expansion) should reappear as mechanical work done by that expansion. For on the molecular theory we are dealing not with two different kinds of energy—mechanical energy, or the ability to perform work, and an energy of a different sort entirely, heat—but rather with mechanical energy on two different scales, the motion of large bodies, and the motion of very small bodies, or molecules. In other words, the theory could not be regarded as complete until it had

been shown that, in the production of work from heat, a certain quantity of heat disappeared and ceased to exist as heat, and that this quantity was the same as that which could be generated by the expenditure of the work produced.

This actual quantitative determination of what is called the "mechanical equivalent" of heat was the task of Joule, and in experimentally verifying that equivalence he conclusively demonstrated the whole kinetic theory of heat. For he succeeded in showing that heat could be regarded as mechanical motion on a small scale, and that it obeyed the laws of all motion. To this end he instituted a number of experiments. He measured the heat produced by a certain amount of electrical energy, and found that it was constant. He measured the heat produced by the expenditure of a certain amount of mechanical energy in compressing a gas, and found that it was exactly equal to the heat produced by the same amount of electrical energy. He found also that the same amount of heat, when converted back into mechanical energy, produced the amount that had been originally expended in creating it. He found that the results so obtained tallied exactly with results when he produced heat by friction. He tried also a number of other experiments, varying greatly his methods each time, and in every case he established the same definite ratio between the amount of heat and the amount of work performed. The great value of Joule's work lay in the variety and the completeness of the experimental evidence he brought forth. It was not, of course, sufficient to find the relation between heat and mechanical work in one particular case. He had to show, to fulfill the requirements of the Method of Agreement, that the same relation held in all cases that could be experimentally examined, and that the "ratio of equivalence" of the different forms of energy, measured in very different ways, was independent of the manner in which the conversion was effected and of the material used. Since Joule's day many more experiments have been devised, and in every case the same result has been secured.[1]

Thus it became possible to affirm a mathematically exact functional relation between heat and energy expressed in other forms of motion. This is made possible by the analysis of all the involved phenomena into physical units termed molecules, defined mathematically, and viewed as moving according to universal laws of motion which are also statable in mathematical form. These molecules in motion, then, constitute the field of mechanics, and every event which can be analyzed in terms of such units in motion becomes by that fact functionally related

[1] Columbia Associates in Philosophy, *An Introduction to Reflective Thinking*, pp. 133-135. Reprinted by permission of and special arrangement with the publishers, Houghton Mifflin Company.

to all other events that are so analyzable. All specific relations between variable mechanical magnitudes can be stated as corollaries, under special conditions, of the general laws of the motion of masses which pervade and determine the entire field.

Significance of verification in terms of functional formulæ

Here the method of experiment by the aid of functional analysis reveals itself at its highest level. Not only are two very diverse types of event shown to be so connected that for every change in the one there is a corresponding determinate change in the other, not only is this relation reduced to an exact mathematical formula, but the function is stated in terms which unite it with all other phenomena analyzable into similar units, making it a corollary of the general laws of behavior of those units and thus establishing an organic system of mathematical knowledge over a large field of nature—the field of matter in motion. The ideal of scientific explanation, of course, would be to reduce all laws of functional connection to functional laws of this exact mathematical type, and then to merge the separate branches of science by discovering some ultimate unit whose laws of behavior could be shown to include and imply the universal relations which previously seemed ultimate in each of these fields. In the inorganic realm much has already been accomplished in this direction. Progress has been made toward uniting chemical and mechanical phenomena under the still broader and more ultimate field of electromagnetism, and a formulation is being sought of the laws of the electron (at present supposed to be the final unit in this field) such that the laws of mechanics and of chemical reaction will be seen to follow from them. Little progress has, however, as yet been made in finding a common unit and law which can unite the inorganic and organic realms; indeed, in the more complex branches of the latter, such as psychology and sociology, no unit comparable in mathematical precision to those of the inorganic sciences has as yet been discovered at all.

The methods that social science has devised of overcoming such difficulties, so far as possible, and of securing what measure it can both of experimental control and of mathematical precision, in dealing with the sciences of the living, we shall attack in the next chapter. In the meantime, let us sum up the dis-

cussion of these verifying procedures by showing how the functional method really includes all the logical virtues of the others and thus becomes the technique of scientific verification *par excellence* wherever it is applicable, and answer certain questions which have undoubtedly arisen in the reader's mind in the course of the discussion.

The logical nature of functional explanation

First, let us observe that the method of functional analysis introduces no new fundamental assumption of the kind stated in the principles of agreement and difference. They are genuinely inclusive in their own way. But it does add the very important assumption that events can be quantitatively dissected, and by adding this assumption it constitutes the most minute and exact application of these two principles to the verification of connections that science has so far been able to develop.

Functional analysis involves the principles of agreement and difference

That the principle of agreement is included in a functional statement is obvious. One entity could not vary in a regular manner with another if one might be entirely absent when the other is present. That the principle of difference is likewise included is not so obvious, for it appeals to situations where both entities are absent, while one of the virtues of the functional method is that it can be used to study regular relations of facts that cannot be entirely eliminated, such as gravity and temperature. But a little consideration will make it evident that this difference is irrelevant to the present consideration. On the one hand it is clear that a statement of one fact as a function of another presupposes, quite as much as the method of difference, that if one of the two facts is entirely absent the other could hardly be present. On the other hand, even if the facts are such as cannot be quite eliminated, the conception of one as function of the other assumes, at every point of their parallel variation, the essential principle of difference, and there is no other assumption beyond that of the possibility of mathematical analysis itself. Let x be a certain value of one variable, y the corresponding value of the other variable. Now to affirm that if to x we add $\frac{x}{10}$ we shall find that in place of y we have $y + \frac{y}{5}$,

or that if we increase x by $\frac{x}{2}$ we shall find that y has doubled, it is evident that we are assuming, with reference to the quantitative increments and decrements of these variables, precisely what we are assuming in the method of difference. That is, we assume that if $\frac{x}{10}$ is introduced, $\frac{y}{5}$ will appear, whereas if the former is eliminated the latter must also disappear. In fact, we might describe the method of function as simply an attempt to combine the experimental procedures of agreement and difference with a systematic analysis of both entities studied into processes of quantitative change.

**What a functional statement adds**

We thus answer by a functional analysis all the questions that can be answered by these methods in the forms earlier studied, and an extremely important further question besides. We know not only that, given the one, the other can be counted on to be present, and that if one is absent the other must be absent likewise, but we also know how much of one maintains this dependable relation with any given quantity of the other. It thus sums up in a simple statement far more adequate guidance for our future problems involving the events in question than any other type of formula that science has been able to devise. It is, accordingly, no wonder that every branch of science strives to apply this dynamic and quantitative type of relation wherever it can, and that the surest mark of the maturity of any branch of science is its ability to organize its field of study in such a way that its results can be stated in functional formulæ. Every investigator ought to make it his primary attempt, whatever be the subjects with which he is dealing, to analyze them in such a way that their relation can be hypothesized and experimented with in functional terms. Only in the event of failure in such an analysis should he use the simpler procedures and set up such limited laws of regular connection as he finds it possible to set up by their aid.

It is obvious, without specific statement, that in certain fields, such as astronomy, functional relations can be established by observation merely, while in others active experiment is required.

Usually also specially devised instruments are necessary as aids to the senses and muscles in carrying out the analysis.

**The assumptions of empirical verification**

Second, since it has been a practice of logic texts to discuss the ultimate assumptions which the scientist makes when he establishes laws of nature by the use of the methods of agreement and difference in the ways above described, it may be pertinent to devote a few pages to this point.

The fundamental assumption is, clearly, that our world is an ordered system rather than a chaos. To some extent this is more a basic fact of experience than an assumption in the usual sense of the word. While we were yet in our cradles, before we made any attempt consciously to analyze nature for the purpose of picking out ordered relations of facts, such relations began to force themselves upon our attention. When we sucked the bottle the milk came, when we cried mother appeared, when the rattle fell it made a bang. Our world gradually proved itself to be replete with many apparently inevitable connections of events, so that given one our expectation of the other was constantly shown well founded by the outcome. With growing experience this ordered system of relations expands. We come to distinguish between those relations of objects or events which seem to be universally dependable and those that have varying degrees of correlation, and we separate both from the ones that, so far as our experience goes, are entirely fortuitous or unpredictable. Thus we learn to adjust our actions to the implications of the events that face us in terms of their outreaching relations—consciousness itself is perhaps properly defined as awareness of something in its ordered relations to other things. The burden at least of the famous "Analytic of Principles" in Kant's *Critique of Pure Reason* is that conscious experience itself would be quite impossible if the field of that experience were not ordered in regular and necessary ways.

**Its necessity in all thinking**

In time men come consciously to realize how important a clear grasp of such sequences is for the attainment of the things that they desire—even before that, for a leisured few dominated by vigorous curiosity, it affords a refined satisfaction. Then the effort is made systematically to seek sequences which had

hitherto remained hidden. This means clear adoption of the assumption that behind even those connections which in their spontaneous appearance seem only imperfectly correlated or quite accidental there are really functioning regular laws of change which by the right methods of analysis and experiment can be discovered, and which, when discovered, will widen our reflective grasp and control of events. Success in finding the right general technique emboldens us to make the assumption still more confidently, and we come to realize more and more definitely, as was noted in chapter nine, that only on this basis can we think clearly about nature at all. It is impossible to get a relevant suggestion to any problem or to deduce its implications unless we assume that there are relations between the factors that enter the problem regular enough to make our outcome pertinent to the original conditions of our thought. Accordingly, even in those baffling social problems where fully dependable relations seem to be out of the question, we find ourselves forced to assume that this is not because they are not there, but simply because so many of them are operating in any given phenomenon that it is impossible to isolate and calculate the precise effect of each singly. We point to the fact that we cannot subject such material to the same ruthless laboratory control as we can inorganic matter and some of the lower animals, where we might isolate one by one these contributing causes, but find ourselves forced to do the best that we can with it even while entangled in such underlying complexity. Hence we apply there the method of correlation, soon to be examined, which involves the same general assumption with the added belief that even where this complexity remains unresolved, it is possible, by a careful enough study of typical cases, to determine the degree of regular relationship present. We assume, in short, that our world is such that, given one event, there is a system of other events involved with it and necessarily dependent on it—that it is a cosmos and not a chaos. And amid the present diversity of scientific fields and laws we carry forward the hope that even this diversity is not ultimate; that there is some underlying and

ubiquitous type of event whose laws will prove to unify and explain everything that happens.

What is its ultimate justification?

But none of the laws so far established by science, even the most inclusive, has been verified for all the cases to which we assume that it applies. Except in those cases where the field of investigation is so small that every instance of the phenomenon can be examined, we assume that the study of typical cases enables us to reason from them to cases not yet presented; we set up, in other words, a universal law on the basis of an analysis of a limited number of particulars. Every law which the scientist seeks to establish is of this character. Nobody would be able to examine the behavior of every piece of matter to see experimentally whether it obeys the law of gravitation, and the same to a less degree holds of all other scientific laws. Science assumes, in short, that generalizations based on the behavior of past events which it has analyzed will be found to hold true of events presented in the future which are sufficiently similar to them to be described by the same terms. This is signified verbally by the universal form of the scientific law; every particle of matter attracts every other particle, etc.; heat (every instance of heat, that is) is molecular motion, and the like. What is the warrant for this assumption? How do we know that the future will be like the past, that the ordered sequences that we have become familiar with in the past will continue to repeat themselves in this accommodating fashion?

Answers of Hume and of Kant discussed

This doubt was first expressed in its full force by the English philosopher David Hume. Granted it to be true that all the cases that we have observed in the past of one billiard ball hitting another have shown a motion communicated to the second from the first; with what right do we suppose so confidently that every similar case in the future will show a like communication of motion? It should be noted that Kant's famous answer to Hume does not really touch this point. If we believe with him that *a priori* forms of necessary connection are essential to the constitution of every experience, the question is still pertinent: With what warrant do we assume that experience is to continue? or in Kant's language, that these forms of necessary con-

nection will continue to find externally given material that can be synthesized in accordance with their nature? Apparently there is no finally satisfactory answer to the question thus phrased. It is like the question: Why should there be any order at all? or, indeed, any universe at all? The only retort to such questions is that they really ought not to be asked, if we admit as a general principle that only answerable questions ought to be asked. Things do go on in the world, we are so constituted as living and thinking beings that we have to read the present in the light of its relations to an expected future, thinking itself involves the attribution of dependable connections within the field of our thought, for we cannot even imagine a future state of affairs that is not connected with the observed present by a chain of definite links. The important point is that while we do not know in any absolute sense that the future will be continuous with the past in its fundamental characters, we have no warrant whatever for any different belief. Accordingly, ultimate probabilism at this point cannot at all justify the notion that some sudden and radical transformation is impending whose arrival will usher us into a quite different state of affairs than any with which the past has made us familiar—a notion often entertained by religious and other sects. If there is to be a future, the only supposition about its nature for which we have any warrant at all is the supposition that it will be related to the past by necessary laws which will include all that has been verifiably established in our present science. To dream some other future is to believe something for which there is no warrant in our experience to date at all, in preference to what has back of it all the warrant possible in a universe that is an adventure as well as a logical system.

**What is the meaning of a universal law?**

It is quite possible to state our general laws in a form that will recognize this expectation about the future to be ultimately a matter of intelligent faith rather than of absolute knowledge, if it seems desirable to do so. It is evident that what we mean when we say that every particle of matter attracts every other particle in accordance with a certain ratio involving their masses and distance from each other is not that we have an absolute

guaranty that everything which we would call a particle of matter must do this, but that in terms of experimental analysis in the past, confirmed by all other related scientific experience to date, this is the only expectation about such a particle that we have any right to entertain. There is no other mode of behavior which we have any justification in expecting. In other words, since to live in the present is to assume that the lessons of the past hold good in the present, it is a legitimate inference from "This is a piece of matter" to "This attracts other pieces of matter in the ratio $\frac{m_1 \cdot m_2}{d^2}$." But it would presumably be rather superfluous to preface every scientific law by the clause, "It is a legitimate inference that," so long as we have faced frankly the issue of the relations of past and future and have realized the limitations of every universal statement. The uniformity of nature, as thus described, is a conviction which, when we examine the situation, we cannot help but hold as long as we choose to live.

**Fallacies of empirical generalization**

It is desirable in the third place to end the chapter with a discussion of the fallacies which may be committed in connection with the use of the experimental methods.

There is really only one fallacy of this sort, although it presents itself in a number of varying forms. This is the fallacy that has often been spoken of in inductive logic as the fallacy of *hasty generalization*. This is, in broad terms, the fallacy of assuming that your result has wider or more dependable application than the data from which it was secured really justify. We may discuss here the more common forms of this fallacy. Much of the discussion will constitute a summary of suggestions already made.

**False analogy**

We may describe as *false analogy* a form of this fallacy that really antedates the systematic use of the experimental methods. This is the acceptance of a belief on the ground of some resemblance which even undisciplined observation would reject as entirely superficial and untrustworthy were it not thrust upon attention by some striking quality and supported by uncriticized tradition. Many superstitions still prevalent at the present day

are of this sort. We may cite as an example the belief among many rural folk that corns should not be pared at the new moon. The reason for the belief, as offered by a backwoodsman's wife, is that "When the moon's growing big the corn's got to grow big too, hasn't it?" That false analogies at times influence even the most sophisticated of us, we shall discover if we examine carefully what unexpected beliefs try to turn up in our thinking on occasion. I found myself feeling a bit squeamish sometimes when my oldest daughter was passing through the age of seven, merely because of the rather vivid association brought about by the fact that she was named for an aunt who had died a rather tragic death at that age. Analogy is of value in guiding our thinking only when it has empirical rather than emotional warrant.

Extending the reach of our generalizations

Coming to the methods themselves, we may note first a form of the fallacy that applies to all of them but which lacks a technical logical name. This consists in assuming that an experimental law holds for a large group, or universally, when the cases on which it is based are only typical of a smaller group. This has been instanced in our illustrations above; it would be committed by an Eskimo who might venture to generalize about hares on the basis of the arctic hares with which he was familiar; it was committed by the king of Siam who listened open-mouthed to many of the tales of a Dutch traveler, but exclaimed when told that in Holland sometimes the water got hard so that people could walk across it, "Now I know you are lying." It is essential to remember that if a law is to be regarded as universal the instances selected for study must represent all the relevant conditions under which the law functions, so far as the investigator is able at any given time to determine and control them. It is precisely because such determination and control are secured most completely by the experimental method of function that wherever this method can be used it plays such a vital part in scientific advance.

Plurality of points of agreement and of difference

When the simple method of agreement is used, we may term this fallacy *plurality of points of agreement.* That is, while on the basis of the observations we have made m seems to be regu-

larly connected with y, further observations might reveal that a hidden factor, n, was also present whenever m was. Thus m and n might prove to be joint causes of y, or still more thorough investigation might show cases where n and y are present and m absent—that is, that n is really the sole cause. Thus it was a long belief that night air was the cause of malaria. This came to be explained in time by the fact that mosquitoes from adjoining woods and swamps, whose bite is the real cause, usually shun light and prey upon people only at night. It was a hidden concomitant of the night air, not the night air itself, which was the source of the trouble.

Examination of the principle of difference reveals also that the fallacy may take the form of *plurality of points of difference.* This means that while on the basis of our observations or experiments we may believe that only the elimination of m is needed for y to disappear, it may be that l, too, was always eliminated with m without our realizing it, and that further experiment would show either that l was a joint cause with m or perhaps the sole real cause. Thus on the basis of early experiments with infusoria, it might have been believed that these animalculæ inhabited the atmosphere generally, since the exclusion of the atmosphere from sterilized liquids prevented their appearance in them. But Pasteur's later experiments showed that they were carried about merely on the dusts of the air. The experimental method of difference, applied under conditions of genuine laboratory control, reduces the danger of this fallacy to the minimum, for under such conditions it is very difficult for an extra causal factor to appear unnoticed. But there may be many minute facts which constantly escape our observation, hence even under these conditions we can never be absolutely certain that plurality of points of difference is avoided. Laboratory experiment makes a much higher degree of control possible, but promises no absolute control.

**Accidental or temporary functional relation**

When the method of functional analysis is used the fallacy of hasty generalization takes the form of mistaking a merely *accidental or temporary concomitance* between two processes of change for a more dependable functional relation. After

having noted for some days, for example, that the street lights come on in my community just ten minutes after sunset, I might set up a general functional relationship in terms of that interval of time between them. But later in the year I might observe a different interval. By more extended observations I discover that my original law was of merely temporary validity, and that it was true for only that part of the year when my first observations had been made. The true functional relation between these variables proves to be statable only in much more complex terms. By following in our investigations, so far as possible, the same precautions discussed in connection with the method of difference, the danger of committing the fallacy may be reduced to a minimum.

What makes us commit these errors?

What are the psychological forces that lead us to hasty generalization in these various ways? Fundamentally, of course, the same with which we were concerned in chapter three, and again when considering the motives to fallacious deduction in chapter seven. The two which might be especially mentioned in the present connection are the tendency to allow a vivid or emotionally appealing circumstance greater weight in one's observations than it deserves, and the tendency to circumscribe our investigations rather narrowly, either because we dislike to remain in suspense, because of too great confidence in prevalent opinions on the matter in question, or because of general mental laziness and inertia. It is clear that the process of verification will not be adequately performed unless these tendencies can be controlled in full obedience to the principles of correct verification above stated. It is worth observing that the fallacies of accident and the converse fallacy of accident, treated in the traditional logic under the head of deductive fallacies, are really forms of the fallacy of hasty generalization. To commit the fallacy of accident is to assume that a general law applies under circumstances which were not taken into account in the formulation of the law or which were meant to be excluded from the range of application of the law, as depending on other factors whose behavior is otherwise expressed. To hold that a man should take no active part in politics just before election time,

on the general ground that a man should devote his energies to his business, would exemplify this fallacy. Clearly this is a case of hasty generalization. A law is interpreted as applying without question to circumstances which were not directly considered in the establishment of the law. The converse fallacy of accident is simply the reverse of this. It assumes that what is true under special conditions must hold good, for no further reason, under more normal situations.

EXERCISE.—A. In the light of the three chapters just studied, describe and criticise the following cases of hasty generalization:

1. I see that all the people in my town who have died this last year have had doctors. When I am sick I shall be careful, therefore, not to call a physician.
2. My friends Tom and Dick got passing marks in Professor Z.'s course without doing any work. I must be sure to take that course next semester.
3. This patent-medicine booklet tells of many people who have been cured of various diseases by taking the medicine advertised, and also of unfortunate people who have died through failure to take it. I gather that it is just what I need to cure me.
4. The tradition arose in the island of St. Hilda that the entrance of a ship in the harbor was likely to cause an epidemic of colds. After a time some one noticed, however, that the harbor was so located that a ship could enter only when a stiff northeast wind was blowing.
5. Ancient and mediæval thinkers generally held that the celestial bodies must move in circles, because a circle is the only perfect form of curve.
6. It is a belief in many seaside communities that babies are born at high tide and deaths occur at low tide. Investigation failed to discover any empirical warrant for the belief. How do you think the belief arose?
7. Mr. A. has been an exemplary man in his family relations, and his friends can always count on his rewarding them for every good turn they do him. He is therefore just the man we need for governor of the state.
8. In the town of Northfield, Mass., in the year 1901, a farmer's house and barn were destroyed by lightning during a brief thunderstorm. His pastor's explanation was as follows: "I warned him only last week that he should attend church instead of spending Sunday bringing in his hay. But he refused to heed my warning."
9. Last week I got into trouble through imbibing too much brandy

and gin. The other day it was ale and gin. And I remember that two months ago I spent a sorry day after an evening with beer and gin. I see, accordingly, that it is the gin that must be responsible. I must give that up and I shall be all right.

10. The present restrictions on sex relations supported by custom grew up in different social conditions, when people did not know how to control the results of such relations. I assume, therefore, that these restrictions have no pertinence at the present time.
11. A spoonful of this medicine cured a light cold that I had last month. Half a cupful, therefore, ought to rid me of this severe one.
12. I notice that when my children are spoken to in a quiet tone of voice they pay no attention, but that when I address them harshly they obey at once. I must, therefore, form the habit of always speaking to them sternly the first time.
13. The more I struggle to improve this book the less does it satisfy me. Therefore it would be better if I erase all my revisions.
14. I observe that the use of brandy does people much harm. It is, therefore, a mistake to use it to revive this man who has just escaped drowning.

B. State as specifically as you can how you would go about it, and what concrete investigations you would make, if it were your business to test the following hypotheses:

1. For some years the winter rainfall in Arizona has been considerably less than normal. It is suggested that the cause is to be found in a shift in the prevailing winds during that season of the year.
2. It has been held that wide fluctuations in the price of grain are due to heavy speculation on the grain exchanges.
3. Since the war the demand for college and university education in the United States has been increasing with unprecedented rapidity. Suggest several possible explanations and indicate how you would test them.
4. The blueberry season this year has been unusually long. I hypothesize that this is due to the lack of any severe hot spells.
5. Since the passage of the prohibition amendment the jails in many of the small cities and towns in the United States have been less populated than before, and savings-bank deposits have largely increased. It is frequently believed that the amendment is responsible for this change.
6. The rapid learning shown by some of the higher animals suggests that they may be able to guide their behavior by images of previously observed situations. How could this suggestion be tested?
7. How would you test the hypothesis that some eating habit into which you have fallen is harmful to your health?

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## CHAPTER TWELVE

# STATISTICS AND CORRELATION

Application of the functional method to more complex problems

ARE these methods of scientific observation and experiment confined in their application to those events whose connections are entirely regular and dependable? Is there a way, in particular, in which the very fruitful method of functional analysis can be made to yield its characteristic mathematical precision in dealing with events which seem to be connected more often than not, but in whose case it is impossible to say that one is a definite and certain function of the other? Many sciences study facts which have not seemed to yield so far to any method of analysis that would enable us to set up functional laws between them of the sort that we are familiar with in physics and chemistry; at least, the more foundational facts have been refractory to such an analysis. For the most part, this is the case with all the sciences that deal with the behavior of living organisms. Either in such phenomena there is operating an essentially uncontrollable and unpredictable element, or the conditions under which their behavior takes place involve too many independent variables for us to disentangle them all and note clearly the part each plays in relation to all the others, or we are pursuing a fundamentally mistaken approach to them so far as concerns the effort to reach exact explanations—whatever be the reason, we find it possible, faced with such organisms, to analyze them into factors many of which are connected in a large majority of cases, but few of which yield absolute laws statable in causal or functional terms. Take the relation of height and weight in human beings, for example. In general, we find that the taller a person is the more he is apt to weigh. But since people are varyingly stout and slender, it is clear that we cannot set up a

functional relation between these two characters. An arrangement of a certain group of people in the order of height would not be likely to be exactly identical with their arrangement in the order of weight; the man who, let us say, is number seven in the first order happens to be rather stout, and accordingly in respect of weight his position turns out to be number five. In other words, no such law can be established between height and weight as is possible between the radius and volume of a sphere. That a given man is six inches over the average height does not enable us to conclude with assurance that he is any definite number of pounds over the average in weight.

This done by the methods of statistics and of correlation

How can science deal with such situations so as to state the degree of relationship that can be verified with mathematical exactitude? The answer is, by the methods of statistics and of correlation. With their aid we are able to reach results, in fields where definite causal and functional laws seem out of the question, which not only give what precise measure of control the situation permits, but also pave the way for the discovery of a more perfect law in the future, if that proves possible, by registering the quantitative degree of correlation that is already verifiable. Let us examine the technique of these methods in some detail.

Meaning of correlation

Correlation has been defined by implication in these preliminary comments. It simply indicates degree of functional correspondence. A correlation between two facts may be stated in terms of probability. To say that a certain correlation coefficient obtains between two variables is to say that there is a certain probability that an individual who is above the norm in one will be found likewise to be above the norm in the other. We cannot say that the one variable is a function of the other, but we can say that there is such and such a degree of functional connection between them, so that, given a specific value for the one, a value of the other will have a certain likelihood, or be determined to practical certainty within definite limits.

A perfect correlation between two variables is thus identical with a functional relation between them; one may argue with complete confidence from a given value of the one to a given

value of the other. Thus there is a perfect correlation between the velocity of a freely falling body and the time through which it has fallen, which we express by saying that its acceleration is constant. *Coefficient* being the mathematical symbol by which we represent the correlation between two variables, such a perfect correlation is represented by the coefficient + 1.00. A perfect negative correlation—that is, an inverse functional relation, is represented by the coefficient — 1.00. This means that for a given increase in one of the variables there is indicated a certain decrease in the other; the correspondence is exact, but in inverse order of magnitude. Thus there is a perfect negative correlation between the gravitative attraction of two bodies and the distance between their centers. Since we have, however, the term function for such perfect correlations, the latter word is ordinarily restricted to situations where the degree of functional relationship is imperfect. Accordingly, in practice correlation coefficients will vary from + .99 to — .99, though such high coefficients as these are very rare and suggest that if our data had been more carefully compiled a true functional connection would be proven.

**Application of correlation coefficients to groups**

It is important to note precisely what a given coefficient means as applied to groups selected at random and to individual members of a group. Suppose it were found, for example, that the coefficient of correlation between the height and weight of human beings were + .50. Would this mean that among a group of four people selected at random who were all above the average in height, two could be expected to be also above the average in weight? Not at all. That would be true if the correlation between them were 0, or none at all. That this is the case will appear on a moment's reflection. If of four people who were above the average in height two were above the average in weight and two below, it would be impossible to argue at all from the one character to the other; the chances are even that a man who is unusually tall will be heavier than the average and that he will be more slender than the average. And this means no definite correlation between the two characters; the coefficient is 0. A correlation of + .50 means a degree of func-

tional relationship halfway between this and a perfect connection. It would, therefore, indicate that of a group of unusually tall people selected at random, you would have a right to expect three-fourths to be heavier than the average. Turning this into a probability statement with reference to any given individual in the group, you would say that the chances were three out of four that he would be heavier than the average. Similarly, a correlation of $+ .75$ would mean a probability of 7/8, while a correlation of $- .50$ would mean a probability of only 1/4. If such a correlation obtained between height and weight, we should expect that of a group of four tall people only one would be above the average weight, while the other three would be below it. That is, there would be three chances out of four that a tall man would be slim and a short man stout. A perfect negative correlation would mean, of course, that if a given group exceeded the average in one character none at all would exceed it in the other, but all would be below it.

The logical nature of statistics

Now how do we proceed to determine the correlation between any two phenomena, either within a limited field or generally? First, of course, we must procure a set of values for each of the variables. This involves a quantitative measurement of these variables as revealed in individual cases, and is the problem of *statistics*. It is worth our while to pause here briefly in order to grasp clearly the principles of logical importance which must be followed in the work of a statistician.

The discovery of quantitative units

These principles are two. In the first place, he must discover some quantitative unit in terms of which he can translate the phenomenon he is studying into a magnitude whose variations are mathematical. For his task is to *count*—that is, to tell *how much* of the phenomenon is present in the locality or under the conditions which determine his investigation. The basic importance of this step is often masked by the fact that many statisticians approach their work with this translation already performed for them, or confine themselves to problems which indicate the unit to be used in their very statement. Thus when statistics are secured on the number of births, deaths, marriages, suicides, etc., in a given community during a certain time, no

difficulty arises about the determination of the quantitative unit to be used—we assume from the very statement of the problem that each case of these events is to be counted as numerically equal to every other. This is true of all the many investigations of social life in which each member of the community is regarded as of equal importance for the purpose of the study as every other member, or where the same holds for a special group within the community. But nowadays we are finding it increasingly important to treat by the same methods of exact analysis phenomena which at first sight appear irreducibly qualitative in their nature, such as intelligence, morality, initiative, memory, ambition, and the like. This means that we must find some way of viewing these characters as quantitative variables, and it is a significant mark of the present epoch in psychological and sociological science that much progress has already been made in securing mathematical statements of some of these characters as present in given individuals or groups. But this can only be done by reducing such characters to a quantitative scale, so that every case of them can be treated as so many times a clearly defined unit or standard of reference. In the case of intelligence and memory this has been done by experimenting with various types of problem; a considerable approximation has been made to a combination of problems such that, in the opinion of the most competent students, ability to solve a certain percentage of them in a given time would constitute an adequate quantitative equivalent for intelligence or memory as possessed by the normal individual at the age studied. At least, in the so-called intelligence tests as used today, a method of measuring intellectual competence has been developed which universities are increasingly finding vastly superior for the purpose to any of the traditional ways of judging these qualities. And it is important to remember that somebody had to discover first even those quantitative analyses of physical changes which we now take as foundational for all our exact thinking about the inorganic world. A large part of the history of astronomy could be written in terms of the attempt to devise an adequate measure of time, and modern physics could not accomplish much

till the same reduction had been made in the case of such phenomena as heat, pressure, attraction, and the like. It is clear that no exact—that is, quantitatively formulated—information about anything can be furnished until this type of analysis has been made.

Importance of social application of quantitative analysis

The ability of science to deal more and more effectively with our most vital human and social problems is dependent to the highest degree on the rapidity with which we become able to perform this quantitative analysis of the other characters which we need to understand precisely and control confidently in the interest of larger human welfare. When we can state exactly what we mean in quantitative terms and can measure numerically such qualities as piety, artistic ability, generosity, statesmanship, sincerity, imaginativeness, love, inventiveness, and can thus work out correlations between them and other distinguishable characters that are more controllable, the progress of mankind toward better things will greatly accelerate its snail-like pace, at least so far as science and logic can bring it about.

Recognition of the limitations of statistical results

The second fundamental principle of statistics is that the limits of the field within which the measurements hold should be carefully determined and clearly stated. Otherwise, what the statistics prove will be quite ambiguous—they will be sure to be variously and falsely interpreted, and large additional warrant will be given for the frequent contradiction of the proverb that figures never lie. In practice this principle is identical with that which must always govern careful observation. Suppose, for example, I wish to know how large a percentage of their waking time people give to political interests, and how this compares with the time given to other interests such as business, family, religion, etc. I visit a number of my neighbors and get them to note for a few weeks the way in which they spend their time, as itemized under a few such heads. Having gathered these data, I proceed to compute the averages and discover as a result that about five and a half per cent of waking time was apparently devoted to political interests, and that four other interests consumed a larger percentage of time. What

is the significance of a result thus reached? Am I justified in setting it up as a general law that people count politics important only to the extent of one-eighteenth of their time and that they make it subordinate to four other interests?

Illustrated by an example

Evidently, this is not justified at all. I must recognize frankly and state openly the limitations of my investigation. Let us note the more important of these limitations. My neighbors who were kind enough to help me in this investigation are all inhabitants of a particular community within a particular part of the city in which I live. I have no right to assume that they are a typical sample of people in another corner of my ward; still less that they are typical of the entire city, not to speak at all of the state, the nation as a whole, or the world at large. Moreover, when I let this geographical limitation suggest others, I see plenty of reasons why they might not be typical. To live where they do, they must all be people whose incomes are within certain definite limits, certain races are practically excluded, and since the majority of them belong to a very few professions, their standard of education and intelligence is not the average standard. Surely these facts are very likely to affect the behavior of these people with reference to the point under investigation. And perhaps it would not be legitimate to announce my percentage as holding even of such a limited community. It might be that the time of year made a difference, or at least its temporal relation to past and coming elections. It might be that my instructions were misinterpreted in charting the time and that another form of outlining the problem would secure a more dependable result. The essential point is that I must recognize all these possibilities and take account of them both in the conduct of my investigation and in the statement of the outcome. I must pick cases which are really typical of the group for which I want my conclusion to hold. Students often assume that mere random selection will secure the variety needed. This is to believe that true laws can be established by caprice or accident. To make sure that the cases studied are as typical of the group as possible, I must take note of all those dif-

ferences within the group (such as race, class, business or profession, education, etc.) which might conceivably affect my result, and I must then distribute my cases among these differences in the same proportion in which they are distributed throughout the group to which I want the result to apply. And as of course there may be some relevant differences which I have failed to take account of, the conclusion still possesses only a high degree of probability for that group. Accordingly, wherever it is possible, each single case within the field to which the conclusion is to apply should be examined, as we do in our census reports and a few other official measurements. Thus alone can probability become certainty, modified only by the difficulty of securing the data at all. But except for very limited areas or groups, the sheer financial expense makes this only possible as yet in those measurements which almost everybody recognizes as of great importance.

**Hasty generalization in statistics**

These considerations furnish also an answer to the question: In what form does the fallacy of hasty generalization usually present itself in statistical inquiries? Outside of the merely inadvertent mathematical mistakes that we may fall into in the course of the calculations, it is evident that the main difficulties lie in these possible errors in the securing and interpreting of our statistical data. The main temptation is to assume that our results apply over a broader field than the facts we have examined justify. To avoid such hasty generalization we must be careful to adhere strictly to the rules indicating over what area the cases we have studied are really typical, and under what limitations, therefore, the correlations we wish to set up may be presumed to hold. The conception of *probable error* has been made use of by the statistician as a way of indicating in quantitative terms how near certain curves and correlations may be assumed to be to the true result sought, and serves as a measure of the degree of certainty reached. The dependability of a result, therefore, increases as the probable error decreases. This matter is explained fully in any systematic treatment of statistics.

Keeping record of each step of the investigation

The above caution concerns particularly the conduct of the statistical inquiry itself. In order to guard as fully as possible against the misinterpretation of one's conclusion and to facilitate its comparison with future investigations, it is essential that a description of the inquiry be published with the proffered conclusion. This description should note painstakingly every step and fact that might conceivably have any bearing on the future checking by other students of the method used and outcome reached. It should state exactly the questions asked; when, where, and how the data were secured; what the attendant circumstances were, and the like. Acceptance of this responsibility is another of the only recently emphasized, but exceedingly fundamental, marks of sound scientific procedure. Should I have made a serious mistake in assumption or method in a statistical inquiry, still if I have been careful to describe my procedure, others may build upon and correct what I have done without needing to cast it aside as entirely worthless. But if I have not done this, and later studies contradict my result, my successors will have no recourse but wholly to disregard my conclusion. To fail in such careful description today is almost certain to lead to the suspicion that the author is trying to get a conclusion that will prove something rather than one that can be objectively verified.

Methods of obtaining correlation coefficients

Granted now that these cautions have been observed in the amassing of our statistical data. We have various characters of living individuals and groups, as regards their presence within certain limited fields, at least, and of inorganic phenomena where the conditions are too complex to predict by the use of more absolute laws, translated into mathematical variables. We need now to find out the correlations of these variables, in order to control them in the most exact way that we can, and in order to suggest how, by a different method of securing units, we may in the future establish more perfect relations. Just how is a correlation coefficient determined between two variables?

This question is answered by different formulæ according to the form of our data and the degree of exactitude which we need

in our result. No attempt is desirable here to present a justification of the formulæ, which involves a lengthy mathematical analysis. We shall take the formulæ as yielding essentially correct results, and simply show how to apply them to specific problems.

The first and simplest of these formulæ enables us to calculate the coefficient of correlation when we know the rank of each of the cases studied in each of the two variables we are correlating, but do not know the exact numerical scores. The result reached by this method only approximates the true correlation between the variables, and not very closely then unless the number of individuals considered is fairly large. But the calculation is much easier than with the more exact method, and for this reason it is sometimes preferred to the latter even when the precise measurements are known, unless it is desirable to secure more than a rough approximation to the correct correlation. Suppose, for example, two high-school teachers, one of algebra and one of history, being dissatisfied with the mere use of a few grades A, B, C, etc., have formed the habit of ranking their classes in order from the best student to the poorest. It happens that in the course of their work they both teach the same class of twenty-two students, and wish to correlate achievement in history with achievement in algebra on the basis of the showing of this class. How shall they calculate the desired coefficient? The formula for such correlation by ranks is Correlation by ranks

$$[\text{illegible}] \quad n(n^2 - 1)$$

Here r stands for the coefficient of correlation by ranks, n for the number of cases, d for the difference between the rank of any individual in one variable and his rank in the other, and $\Sigma$ is the mathematical symbol for "sum of." The numerator in the fraction of the formula therefore reads: six times the sum of the squares of the differences between the rankings of the individuals in the two variables. Let us see how, by the use of this formula, the two teachers would work out their problem. Their data are set forth in the first three of the columns below.

| Individual in class | Rank in history | Rank in algebra | Difference in rank | Square of difference |
|---|---|---|---|---|
| T. G. | 12 | 11 | 1 | 1 |
| R. L. | 19 | 14 | 5 | 25 |
| H. Y. | 8 | 10 | 2 | 4 |
| S. B. | 5 | 3 | 2 | 4 |
| I. M. | 9 | 9 | 0 | 0 |
| Y. P. | 2 | 5 | 3 | 9 |
| V. C. | 21 | 19 | 2 | 4 |
| P. L. | 14 | 15 | 1 | 1 |
| J. T. | 6 | 7 | 1 | 1 |
| W. F. | 11 | 16 | 5 | 25 |
| A. D. | 22 | 18 | 4 | 16 |
| R. R. | 17 | 20 | 3 | 9 |
| C. K. | 4 | 1 | 3 | 9 |
| O. U. | 7 | 6 | 1 | 1 |
| Y. M. | 13 | 8 | 5 | 25 |
| A. R. | 18 | 21 | 3 | 9 |
| B. O. | 16 | 22 | 6 | 36 |
| K. I. | 1 | 2 | 1 | 1 |
| P. S. | 3 | 4 | 1 | 1 |
| A. L. | 10 | 17 | 7 | 49 |
| M. N. | 15 | 12 | 3 | 9 |
| F. D. | 20 | 13 | 7 | 49 |
| | | | | 288 |

The fourth and fifth columns are then added, which consist in the differences in ranking of the individuals studied and the squares of those differences, respectively. The sum of the latter column is then attained, which proves to be 288. Since we know the number of students in the class to be 22, we may now express our equation:

$$1 - \frac{6 \times 288}{22(22^2 -}$$

Solving, $r = 1 - \dfrac{1728}{22(484 - 1)} = 1 - \dfrac{1728}{22 \times 483} = 1 - \dfrac{1728}{10626}$

$= 1 - .162 + \qquad = .837 +$

There proves thus to be a very high positive correlation between achievement in these two subjects as revealed in the work of these pupils. Of course (to repeat a warning given above) it would be fallacious for these teachers to assume that this cor-

relation would necessarily hold for any other class working under any other conditions than those obtaining at that school at that time, or that it represented more than an approximation even under those limits.

What should be done in using the method of correlation by ranks when two or more individuals are tied with respect to their ranking in one of the variables? The only procedure that can be followed in this case is to assign each of the tied individuals an average of the ranks they would have occupied if it had been possible to distinguish between them. Thus suppose, in the above case, that the history teacher had been unable to distinguish between the achievement of Y. M. and P. L. Then each of them would have been ranked 13.5, and there would have been no individuals ranked 13 or 14. Similarly, if the work of H. Y., I. M., and A. L. had been impossible to distinguish, each of them would have been ranked 9, the average for 8, 9, and 10. But if there are many such tied individuals, especially if the group is small, the result will not be worth very much as an indication of the true relationship of the variables.

**The Pearson correlation coefficient**

The second formula is known as the Pearson correlation coefficient, since it was worked out mathematically by one of the great leaders in the field of biometrics, Karl Pearson. It aims to give an exact measure of the degree of relationship between two variables when we have the numerical measurements of a group of individual cases of each of the two variables.

Let us take a very simple case first. Suppose we are residents of Portland, Oregon, and are interested in the climatic conditions of our locality. We know the average rainfall and also the average percentage of possible sunshine for each of the months of the year, as determined by Weather Bureau records reaching over a period of fifty years or more. We wish to secure the correlation between these two variables. Now the Pearson formula is:

$$n \,.\, \sigma_x \,.\, \sigma_y$$

Here x = the deviation of the values of the x variable from the mean value of that variable, y = the deviation of the values

of the y variable from their mean value, n = the number of cases studied, and $\sigma_x$ and $\sigma_y$ = the standard deviations of x and y, respectively. By "standard deviation" is meant mathematically the square root of the average of the squares of the deviations. Symbolically, $\sigma_x = \sqrt{\frac{\Sigma x^2}{n}}$ and $\sigma_y = \sqrt{\frac{\Sigma y^2}{n}}$, since the mean or average of any group of numbers is found by computing their sum and dividing by the number in the group. To apply the formula, accordingly, we need, in addition to the columns giving the values of the two variables, columns each for x, y, $x^2$, $y^2$, and xy. We prepare our data sheet then as follows:

| Month | Rainfall in inches | Percentage of possible sunshine | x | y | $x^2$ | $y^2$ | xy |
|---|---|---|---|---|---|---|---|
| Jan. | 6.6 | 26 | 2.9 | −18 | 8.41 | 324 | −52.2 |
| Feb. | 5.8 | 30 | 2.1 | −14 | 4.41 | 196 | −29.4 |
| Mar. | 5.0 | 39 | 1.3 | −5 | 1.69 | 25 | −6.5 |
| Apr. | 3.1 | 48 | −.6 | 4 | .36 | 16 | −2.4 |
| May | 2.4 | 47 | −1.3 | 3 | 1.69 | 9 | −3.9 |
| June | 1.6 | 54 | −2.1 | 10 | 4.41 | 100 | −21.0 |
| July | .6 | 71 | −3.1 | 27 | 9.61 | 729 | −83.7 |
| Aug. | .6 | 65 | −3.1 | 21 | 9.61 | 441 | −65.1 |
| Sep. | 1.7 | 53 | −2.0 | 9 | 4.00 | 81 | −1.8 |
| Oct. | 3.5 | 44 | −.2 | 0 | .04 | 0 | 0 |
| Nov. | 6.6 | 25 | 2.9 | −19 | 8.41 | 361 | −55.1 |
| Dec. | 7.1 | 23 | 3.4 | −21 | 11.56 | 441 | −71.4 |
| | 44.6 | 525 | | | 64.20 | 2723 | −392.5 |
| Mean = | 3.7 | 44 | | | Divided by 12 = | | |
| | | | | | 5.35 | 227 | |
| | | | | | Square root = | | |
| | | | | | 2.31 | 15.1 | |

The first thing to do now is to secure the mean value of the rainfall per month and the mean percentage of possible sunshine per month. These we find by adding the totals of each column and dividing by twelve, the number of months. Disregarding further decimals, these mean values turn out to be 3.7 inches and 44 per cent, respectively. To make up the x column now we subtract the mean value of x from each of the individual values

being careful to note whether the result is + or — in every case. This gives us the deviations of the values of the x variable (rainfall) from its mean. To secure the corresponding deviations of the values of the y variable we likewise subtract its mean value, 44, from each of them. Next, by squaring each of these deviations we make up the $x^2$ and $y^2$ columns, which we shall need in computing the denominator of our fraction, and by multiplying each x deviation with its corresponding y deviation we fill out the xy column. Notice that the squares of the deviations will always be plus in sign, while their products may be either plus or minus. In this case they happen to be all minus, which indicates that we shall find a rather high negative correlation between these variables. We are ready now to add up the xy column, which gives us the numerator of our fraction, — 392.5. Next, we add up the $x^2$ and $y^2$ columns. By dividing in each case by the number of months and taking the root we have the values for $\sigma_x$ and $\sigma_y$. We are then ready to solve the equation as a whole.

$$r = \frac{\Sigma xy}{n.\sigma_x.\sigma_y} = \frac{-392.5}{12 \times 2.31 \times 15.1} = \frac{-392.5}{418.57} = -.93+$$

Again, it is worth emphasizing that this correlation has been found to hold only for Portland and during the period of the Weather Bureau reports. The latter is long enough to make the result pretty dependable unless some sudden change should occur in the conditions governing Portland's climate. But we should err greatly if we should assume that such a high correlation would obtain in many other places. In fact, we find by comparison that it does not. In Hawaii, for example, the average rainfall is nearly two inches per month, but the percentage of possible sunshine is nearly as high as in the arid desert of southern Arizona. This is because much of the rain falls during the night, and there is practically no cloudy weather except when rain falls. Again, in more northerly climates than Portland there are many localities where the rainfall is quite light, but where the sky is overcast with clouds a considerably larger percentage of the time than at Portland.

**Helps in dealing with more compli-cated data**

The above is a very simple problem for the Pearson formula. The average values for each of the months of the year are already determined for us, and none of the figures with which we have to deal is very large. When such simple conditions do not obtain, statisticians have provided certain helps which facilitate the calculation. In a general logical treatise such as the present it is hardly necessary to present these in full. In cases where the separate values for each variable need to be calculated from the original observations as well as used to establish a correlation between the variables, these helps consist mainly in special data sheets, indicating precisely the places in which all figures should be entered, and the order in which the calculation should proceed. In cases where the Pearson formula leads to unusually large numbers which are awkward to handle, the formula may be modified in such a way as to replace the original x and y numbers by equivalent scales. The formula as thus modified reads as follows:

$$- n . m_x . m_y$$

$$\sqrt{\Sigma(x^2) - n . m_x^2} .$$

Here $m_x =$ the mean of the x values, and $m_y =$ the mean of the y values. But we need not illustrate these complexities; the student will find them ably and clearly expounded in the little work of L. L. Thurstone on *The Fundamentals of Statistics*, and elaborated in further detail in the larger books on statistics, such as those of Yule and Bowley.

**What knowl-edge of the indi-vidual does cor-relation give?**

In concluding this discussion of correlation it is essential to notice the limitation of the kind of knowledge which it yields, particularly with reference to predictions about individual cases. A coefficient of correlation, we have said, states the degree of relationship between two variables. Now each of these variables consists of a group of values, related quantitatively, and each of these values represents a number of individual cases. What knowledge does the statistical grouping of these cases into the form of a mathematical variable give us about any particular case, and what knowledge is given about it when that variable is correlated with another? The answer in each case must be

expressed in terms of probability. Statistical *knowledge* is always about the groups to which these individuals belong; the predictions which we can make in terms of knowledge are always about these or similar groups, for we can predict nothing with certainty about any individual member of the group. Take the hypothesized result of my inquiry into the political interest of my neighbors. The average percentage of waking time given to political affairs which I then discovered (five and a half) is the percentage for the group; though it was the average for the individuals studied, it might happen that no single one of them gave exactly that amount of his time to politics. They simply clustered most closely around it. Accordingly, when I use this result as a basis of prediction, I must bear in mind what this involves; I can only predict that a group influenced by the same relevant forces will show the same average. As applied to an individual about whom we know nothing relevant except that he belongs to such a group, this knowledge becomes only a statement of probability, but it is important to observe that it gives us the most accurate information about such an individual that the available facts make possible. That is, if I know about a man simply that he belongs to a group such as my neighbors constitute, I can say with assurance that it is more probable that he devotes five and a half per cent of his waking time to political affairs than any other amount that could be named. And it is highly significant to know this much; at least it is better than a guess based on no definite data at all. Similarly, with the information given by the correlation between two variables, although in this case we can state the probability in the form of a definite fraction. Suppose the correlation, for example, between blond hair and blue eyes has been found to be $+ .67$. This means that we can predict, with a degree of confidence determined by the extent and care with which the inquiry was conducted, that in any sizable group of blond-haired people five-sixths will also have blue eyes. But obviously we cannot tell in advance which of the individuals in the group will constitute the one-sixth without blue eyes. Accordingly, if

we know nothing about a girl except that she has blond hair, we can say simply that there is a probability of 5/6 that she will have blue eyes. Again, it is much more exact to be able to say this than to make a guess based on hit-or-miss observation, even though in any given case our expectation may be disappointed.

Importance of exact social science for human problems

And these considerations enforce the great human importance of systematically secured statistics and correlation coefficients. Look at the way, for example, in which most of us at present choose the business or profession to which we intend to devote the major energies of our lives. Even eliminating the large number who simply drift into a calling without any assignable reason, all but a few of the rest decide this very important question in ways that could hardly be logically justified. Some enter a calling because it is their father's, others because it expresses the first serious interest which had come to appeal to them, others because it offers an immediately attractive income, still others because it is the career pursued by an admired hero. Need we wonder that there is so much unhappiness in life, or that work and play seem quite impossible to combine for so many people? Suppose we had statistical information as to what qualities and in what precise degrees success in the various professions was most highly correlated, and likewise a system of tests by which we could tell, in the case of any boy or girl, just how he or she ranked with respect to these qualities, allowing for indications of future promise as well as for present achievement. Then by comparing the chart of any youngster with these "career specifications," it would be possible to say in just what calling he or she would be most likely to reach the highest attainments that capacity and interest permit. In the case of any given individual, of course, the guidance thus founded might prove mistaken, but since it would rest on the most accurate quantitative analysis that had so far proved available, it would be a thousandfold more dependable than the unscientific methods now used. It is hardly too much to expect that such a change would accomplish more toward making life worth living for the

mass of men than any other single social change that has occurred or might occur. And this is only one of a host of valuable applications of the method of correlation. The ultimate key to the problem of divorce and of marital infelicity in general is perhaps to be found in scientific analysis, through statistics and correlation, of the various traits of character with respect to harmony in wedlock, combined with accurate tests of each individual as regards the possession of these traits. It is not impossible that the habit of following such scientific guidance in entering matrimony may come to operate as a very strong restraint on the unstable emotional attraction that at present seems to be almost the sole determining factor. There is no field of relations in which this method of research does not promise the most dependable knowledge at any moment attainable, nor in which it cannot helpfully suggest the direction in which perfect functional relations might be discovered in the future.

Principles and value of statistics illustrated by a recent investigation of nonvoting

In order to realize the real advance in our thinking about social problems that has already been brought about by the systematic use of the statistical method, and something of its promise for the future, it is desirable to consider in all its main logical bearings a typical recent investigation. This will also give us an insight into some of the concrete problems which such inquiries face, and will illustrate some of the concepts and procedures which they are led to use, in a way which is impossible in a merely general discussion.

The illustrative investigation chosen is that performed under the leadership of Professors Merriam and Gosnell of the Department of Political Science of the University of Chicago, respecting the nonexercise of the suffrage by people most of whom have the legal right to exercise it. The studies were carried out during the two years subsequent to the mayoralty election in the city of Chicago held in April, 1923. Their purpose was to determine, within the limits set by the inquiry, the causes of nonvoting (meaning by causes, as the authors explain, whatever facts can be related to this condition), and the methods by which it can be controlled.

Contrasted with other methods of dealing with such problems

It is significant to contrast the type of study thus embarked upon with certain other ways in which people have approached such a problem. The main fact which makes such a study of interest in our day is the fact that the extension of the suffrage to more and more groups of people in the modern world has been paralleled in many countries by a decline in the percentage of those who avail themselves of the right to vote when possessing it. In the United States, for example, the percentage of adult residents of the country who have voted at national elections has declined from more than 80 in 1896 to an average of about 52 per cent in the last two elections. What shall be done about this condition? The impulse of some, of course, is to say, "Compel people to vote." If citizens will not voluntarily exercise their responsibilities, force them by law to do so. In fact, countries such as Belgium, Czecho-Slovakia, and Australia have put into effect such a compulsory policy. But to proceed at once to do something without finding out the clarifying facts about the situation is a pre-scientific method entirely; in this illustration it assumes without thorough consideration that it is desirable to have everybody vote at all costs. The evils that might result from such a method of dragging people willy-nilly to the ballot box are passed by without any investigation of the causes which keep people from voting, of the dangers that such an investigation might reveal in the compulsory method, and of alternative ways of dealing with the problem that might thus appear to be much more likely to increase the vote without running afoul of any compensating evils.

Such as deduction from general principles

Again, we might endeavor to solve the problem by deducing from our general knowledge of human life conclusions as to why many people do not vote, and attempt to remedy the situation by modifying the causal factors which thus seemed to be indicated as the ones primarily responsible for nonvoting. This method would be far superior to the one of immediate compulsory voting, for it would bring to bear the accumulations of past experience on a genuine effort to understand the reasons for the condition we wish to change before we allow ourselves to proceed to a remedy. In discussing related questions

about the lack of attention the average citizen gives to public affairs, Viscount Bryce develops in outline the kind of solution to which this would naturally lead.

The majority of citizens generally trouble themselves so little about public affairs that they willingly leave all but the most important to be dealt with by a few. The several kinds of interest which the average man feels in the various branches or sides of his individual life come in something like the following order:

First, the occupation by which he makes his living, which, whether he likes it or not, is a prime necessity.

Secondly, his domestic concerns, his family and relatives and friends.

Thirdly, but now only in some countries, his religious beliefs or observances.

Fourthly, his amusements and personal tastes, be they for sensual or intellectual enjoyments.

Fifthly, his civic duty to the community.

The order of these five interests, of course, varies in different citizens; some men put the fourth above the second, some so neglect the first as to be a burden to others. But the one common feature is the low place which belongs to the fifth, which for more than half the citizens in certain countries scarcely exists at all. For nearly all—and this will obviously be most true where women possess the suffrage—because domestic cares necessarily come first in the mind and time of most of them—the fifth fills a very small place in the average citizen's thoughts and is allowed to claim a correspondingly small fraction of his time.[1]

Now if we should proceed on the basis of such an analysis as this to deal with the task of increasing the vote, what difficulties might we run into which a better logic would have enabled us to avoid? (It is not implied, of course, that Viscount Bryce intended the analysis to be used in this way.) Clearly those which any mere dependence on the principles generally established by past experience is apt to involve. For one thing, we have no definite empirical verification of the above thesis respecting the relation of the average citizen's political interest to his other interests. A direct study of the facts might show such a thesis to be sound in general, but requiring modification in certain particulars. For another thing, we might find other important causes of nonvoting which coöperate to a definite extent with the subordination of political interest here indicated,

[1] *Modern Democracies*, II, p. 547 (copyright 1921). By permission of The Macmillan Company.

and which could not sanely be neglected in the formation of a remedial policy. In fact, this is the scientific method practiced in general in the mediæval period, the method of trusting implicitly to deductions from previously established knowledge. It parallels, for social problems, the stage in physics when final appeal was made to Aristotle's theorems about natural changes, these theorems themselves being mostly deductions from general principles about the universe at large which seemed well attested. And since there is no pressing need to act at once about the matter, which might justify doing the best we could with the now available knowledge, what defense can be made for not proceeding first to the most careful examination of the relevant facts about nonvoting that we are in a position to secure, and the development from them of such correlations as might indicate definite clues for treatment?

Scope of the study

It was such an investigation that Professors Merriam and Gosnell undertook to make. The investigation was carried out on a very meager scale, for funds and competent investigators were lacking to give it more comprehensive scope. It was restricted, in fact, as noted above, to a single election in a single city, and accordingly the authors attempt no generalizations from their results as to what would be true of other elections in other localities. Together with one or two studies by European investigators, it constituted the merest beginning of exact scientific approach to an important type of social problem—but it was a beginning, and could, of course, be combined with future studies of other elections and in other places to yield in time legitimate generalizations of broader application.

How did these authors pursue the inquiry, and what discoveries did they make?

They found, to begin with, that the number of votes cast in the mayoralty election was 723,267. What percentage was this of the adult citizens of Chicago at that time? Now the 1920 federal census gave as the number of adult citizens in Chicago in that year 1,366,515. The census estimate in the middle of the year 1923 was that the total population of Chicago had increased 7 per cent over the number in 1920. Assuming that

the ratio of adult citizens to the total population was the same in 1923 as in 1920, 7 per cent was accordingly added to 1,366,515, giving 1,460,000 as the approximate number of adult citizens of Chicago at the time of the 1923 election. The percentage of citizens who voted was therefore 723,267/1,460,000, or 49.5 per cent, substantially identical with the percentage of adult Americans who had voted in the national election of 1920. Subtracting the number of voters from the total, we have 744,369 as the approximate number who did not vote. Now what facts should we try to find out about these nonvoters in the hypothesis that those facts might throw some light on the reasons why these people did not go to the polls? For every investigation, as we have noted many times, must be guided by a hypothesis of what kind of result is likely to prove illuminating. Novel results of moment do not thrust themselves upon us unless we are looking for something like them.

**Types of data sought**

The guiding assumption of the investigators was that helpful correlations would be likely to appear if such facts as the following were discovered about these nonvoters: sex, age, occupation, income, whether registered or not, whether native or foreign-born (and if the latter how long had been their residence in the United States), whether of foreign parentage or not, and finally what reasons they themselves, supplemented by the judgment of people expert in practical politics, would offer as to why they did not vote. The inquiry was accordingly directed in such a way as to secure the most accurate facts possible on these points.

On the first of these points definite facts could be secured easily. The records of the Board of Election Commissioners showed that of the 723,267 citizens who voted 464,289 were men and 258,978 were women, 64 per cent and 36 per cent, respectively. Comparing this with the federal census percentages of men and of women in the city, which showed a slight excess of women, it was possible to determine the percentages of men and of women who did not vote. These percentages were 36.7 and 63.3, respectively. In other words, a little calculation was all that was needed to show that on this election

almost two-thirds of the women of the city did not vote, as compared with a little more than one-third of the men.

Selection of the nonvoters to be studied

Exact data on the other points could not be secured so easily, however. And obviously three-quarters of a million people could not be individually interviewed for the purposes of the investigation without far larger funds and a greater number of competent students than were available. Accordingly, it was necessary to get a group small enough to make personal interview possible, but a group representative in every relevant respect of the entire body of nonvoters, so that statistics developed from its examination should hold within a narrow margin of error for the entire group of nonvoters. How was this to be done? Well, the census records gave facts which made it possible to deduce the percentage of distribution within the adult population of Chicago of native whites of native parentage, native whites of foreign parentage, negroes, foreign-born whites, and, in the case of the latter, the main racial affiliations. By selecting for the correlations, then, a group revealing roughly the same percentages of distribution in these respects as was revealed in the entire city, it was possible to insure its representative character with reference to such matters. The number of nonvoters originally interviewed was around 6,000, but for the purpose of deriving the significant statistics nearly 700 were thrown out, in order that the percentage of distribution should closely agree with that in the population at large. Most of those thus eliminated were negroes. This brought down the group statistically examined to the number of 5,310. Fig. I indicates the comparison of the percentage of distribution in the respects just noted of these 5,310 nonvoters with the adult community at large, indicating how representative the investigators were able to make the group studied.

Another way of testing the representative character of the group

Moreover, there is another way by which it becomes clearly indicated whether the group examined is representative of the entire community or not. Are the percentages with respect to the hypothesized causes reached in the early portions of the group studied, maintained without substantial change in the later portions of the group? If they are, this is a strong in-

FIG. I[1]

| Color and nativity | Adult citizens in Chicago (1920 census) | | Adult nonvoters interviewed (election of April 3, 1923) | |
|---|---|---|---|---|
| | Number | Per cent distribution | Number | Per cent distribution |
| Total | 1,366,515 | 100.0 | 5,310 | 100.0 |
| Native white—native parentage | 345,017 | 25.1 | 1,323 | 25.0 |
| Native white—foreign parentage | 529,800 | 39.0 | 1,308 | 25.0 |
| Native white—parentage unknown | ........ | ...... | 331 | 6.0 |
| Negro | 88,620 | 6.0 | 350 | 6.6 |
| Foreign-born white—naturalized | 403,078 | 29.9 | 1,998 | 37.4 |
| Country of birth of foreign-born white: | | | | |
| England and Canada | *25,461* | *1.9* | *99* | *1.8* |
| Ireland | *41,455* | *3.0* | *123* | *2.3* |
| Germany and Austria | *99,123* | *7.2* | *368* | *6.9* |
| Norway, Sweden, and Denmark | *53,939* | *4.0* | *303* | *5.7* |
| Russia | *39,068* | *2.9* | *277* | *5.2* |
| Poland | *43,840* | *3.2* | *286* | *5.4* |
| Czecho-Slovakia, Jugo-Slavia, and Hungary | *39,154* | *2.9* | *239* | *4.5* |
| Italy | *18,156* | *1.3* | *268* | *5.0* |
| All other countries | *42,882* | *3.5* | *35* | *0.6* |

dication that the group selected is genuinely representative, and that if it were enlarged the percentages reached would vary only very slightly from those already established. This situation was quickly revealed in the inquiry in question. "That the sample taken was fairly representative is further shown by the fact that the characteristics found in the first small samples were maintained in other and larger samples as the inquiry went on. The later material accumulated, for example, in racial analysis, confirmed the earlier material, thus giving con-

[1] This and the following tables quoted by permission of the University of Chicago Press.

sistency and uniformity to the sample, and tending to establish its representative nature." [1]

Use of a control group

But now the question arises: Shall we endeavor to make the sample representative likewise with reference to the distribution of different age groups, of occupations, and according to income? The investigators did not attempt to do this, for they hypothesized that significant causes of nonvoting might appear in connection with such relations, and that accordingly it was more important to compare the status of the nonvoters in these respects with a representative group of voters than to make the nonvoters themselves representative of the community. And to do this another preliminary problem needed to be solved. For purposes of such a comparison it was necessary to secure what the social scientist calls a *control group*—that is, a group of similar size and similar general characteristics, but which differs from the group primarily studied in the essential point under investigation. In this case such a group would mean a group of voters, of similar size and equally representative in general of the whole community. To serve as such a control group Professors Merriam and Gosnell selected from the books of the Election Commissioners the facts available regarding 5,159 people who were registered for the same election, taken from the same areas of the city as the nonvoters studied. The books gave data regarding their age, sex, nativity, term of residence, etc., and these made it possible to compare them with the nonvoters in these respects. Moreover, by such a control group possible causal factors connected with the points in respect to which the nonvoters were representative of the community, could likewise be suggested, for comparisons could be made between the percentage of nonvoters who were of foreign parentage and the percentage of voters of foreign parentage, etc.

Results of the study—influence of sex, color, and race

What suggestive results were attained by the investigation? First, as to the influence of age on nonvoting, in the case of sex, color, and nativity groups. The inquiry showed that with men the factor of age made no appreciable difference; with native

[1] Merriam and Gosnell: *Non-Voting, Its Causes and Methods of Control,* p. 7.

whites nonvoting was less among the younger adults and increased slightly with age; the same was true to about the same degree with the foreign-born and with the women, the line of division in all these cases being slightly earlier than the middle thirties; while in the case of the negroes quite the reverse situation appeared, nonvoting being far above the average in the age groups from twenty-one to thirty-nine, while it descended far below the average for the voters in the groups from forty to fifty-nine. Such a result, of course, suggested further reasons for these variations, and would offer a guide for investigations designed to discover definitely the reasons for them, thus making possible an intelligent remedial policy. Without the facts which this study revealed, few would have had any clear notion at all as to the actual status of nonvoting with respect to the relation between age groups and such sex, color, and nativity distinctions. Fig. II gives the statistics on these points.

The next matter analyzed by the authors was the relation with respect to nonvoting between racial and nativity distinctions and the length of residence in Cook County (the county within which the city of Chicago is contained). Beyond showing, however, that a short term of residence in the city kept many people of all these groups from voting, the table indicates nothing of clear significance and is hence not given in detail here. The major considerations which prevented such short-term residents from voting appear in one of the later tables.

Reasons given by the nonvoters for their behavior

What reasons, now, appeared to these 5,310 people themselves to be the main factors which deterred them from voting? A considerable portion of the effort of the investigators was devoted in their interviews to the securing of data on this point. Expert judgment on it was obtained also from party precinct committeemen and others presumed to be skilled in such matters, and where these judgments were clear and well considered they corroborated the results of the statistical survey. The reasons assigned were tabulated under twenty separate heads, combined under four more general groups, and the results thus reached for the group of nonvoters taken as a whole are presented in Fig. III. In this table only one reason is given for

RE D V NONVOT EC SEX LOR, NATI N S ER

DI UTIC

whi For

voters intervie

| | | Both habitual | | | | Registered voters | | voters | | | voters | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| numl | 9 | 5,27 | 1,820 | 3,313 | 1,6 | 8 | 3,6( | 2,520 | 2,948 | 42:2 | 2,21 | |
| nt | 0 | 00. | 100.0 | 00.0 | 100 | C | 00. | 00.0 | 00.0 | 00 0 | 00 0 | |
| 29 | 28.4 | | 3 | | 6. | 0 0 | | 40 8 | 5.0 | 1.8 | | 0 |
| 39 | 27.9 | 9 | 6 | | 9. | 3 | | 29 8 | 0.8 | 0.7 | | 6 |
| 49 | 20.4 | 1 | 8 | | 0.6 | 5 | | 15 | 7.1 | 8.6 | 4.6 | 7 2 |
| 59 | 14.0 | 3 | 0 | | | 8 | | 8 | 0.8 | 4.2 | 0.2 | 8 6 |
| and | 9.3 | 0 | 0 | | | | | | | 4.7 | | 7 8 |

FIG. III

REASONS FOR NOT VOTING GIVEN BY NONVOTERS INTERVIEWED

| Reasons for not voting | Number | Per cent distribution |
|---|---|---|
| All reasons. | | 100.0 |
| *Physical difficulties:* | | |
| Illness. | 647 | 12.1 |
| Absence | | 11.1 |
| Detained by helpless member of family. | 115 | 2.2 |
| *Legal and administrative obstacles:* | | |
| Insufficient legal residence. | | 5.2 |
| Fear of loss of business or wages. | 289 | 5.5 |
| Congestion at polls | 44 | 0.8 |
| Poor location of polling booth | | 0.8 |
| Fear of disclosure of age | 14 | 0.3 |
| *Disbelief in voting:* | | |
| Disbelief in woman's voting | 414 | 7.8 |
| Objections of husband | 54 | 1.0 |
| Disgust with politics. | 230 | 4.3 |
| Disgust with own party | 105 | 2.0 |
| Belief that one vote counts for nothing. | 79 | 1.5 |
| Belief that ballot box is corrupted | 40 | 0.7 |
| Disbelief in all political action | 22 | 0.4 |
| *Inertia:* | | |
| General indifference | 1,347 | 25.4 |
| Indifference to particular election | 129 | 2.5 |
| Neglect: intended to vote but failed | 448 | 8.4 |
| Ignorance or timidity regarding elections. | 378 | 7.1 |
| Failure of party workers | 47 | 0.9 |

each individual; this did not do much violence to the data, for in three-fourths of the cases there was but a single reason given, and in many others it was clear which was the more important cause. For some of the purposes of the later tabulations, however, all the reasons definitely given were included.

The table itself indicates some very important factors bearing upon nonvoting. General indifference to the responsibility

of citizenship accounted for one out of every four of the cases of nonvoting. One out of twelve intended to vote, but neglected to remember or make careful provision of time on election day to perform the function. One out of fourteen was ignorant or timid regarding the process of voting. Counting together all the factors that could be included under the general head of inertia, nearly 45 per cent of the nonvoters failed to go to the polls because of one or another of these causes. Other reasons worth noting in this general table are that one out of twenty failed to vote because of insufficient legal residence, and a slightly larger number because they feared loss of business or wages; while one out of four in the entire group was prevented from voting either by illness or by absence from home on election day.

**Indicated policies of social hygiene**

With reference to this latter situation the investigators found some cause to suspect that illness was occasionally given as a "good" rather than "real" reason; but a still more interesting fact was that, although Illinois, in common with most other states, makes definite provision for taking care of sick and absentee votes, none of the more than 1,200 people who offered illness and absence as reasons knew of the existence of such provisions. This result suggested definite corollaries for future policy. Yet, even had they known of such provisions, would they have made the effort necessary to comply with them? This is especially dubious in the case of the sick, for the law provides that application must be made in person before the central office of the Board of Election Commissioners, or else it must be sworn to before a clerk of court of record and delivered under seal. If a person is too sick to go to the polls and register or vote, he will not be much more able to perform these duties; accordingly, the question of the advisability of modifying these laws in such a way as to enable such citizens to vote as easily as others is strongly suggested.

**Relative influence of these reasons in selected portions of the group**

What about the relative influence of these reasons in the case of men and women, negroes and whites, native-born and foreign-born, people of different income-groups and professions, and the like? Such was the further question to which our au-

## FIG. IV

**REASONS FOR NOT VOTING GIVEN BY NONVOTERS OF SPECIFIED SEX, REGISTRATION STATUS, AND VOTING EXPERIENCE: PER CENT DISTRIBUTION**

| Reasons for not voting | Total † | Sex | | Registration status | | Voting experience | | |
|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Registered | Not registered | Voted in Chicago | Voted elsewhere | Never voted |
| *All reasons:* | | | | | | | | |
| Number* | 5,310 | 1,681 | 3,629 | 1,919 | 3,369 | 3,045 | 385 | 1,841 |
| Per cent | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| *Physical difficulties:* | | | | | | | | |
| Illness | 12.1 | 8.6 | 13.8 | 19.9 | 7.7 | 17.4 | 7.8 | 4.5 |
| Absence | 11.1 | 21.7 | 6.2 | 19.5 | 6.2 | 16.0 | 11.2 | 2.4 |
| Detained by helpless member of family | 2.2 | 0.7 | 2.8 | 3.2 | 1.6 | 2.9 | 0.3 | 1.4 |
| *Legal and administrative obstacles:* | | | | | | | | |
| Insufficient legal residence | 5.2 | 8.6 | 3.6 | 0.8 | 7.6 | 2.6 | 26.2 | 5.1 |
| Fear of loss of business or wages | 5.5 | 12.9 | 2.0 | 10.0 | 2.9 | 7.8 | 4.4 | 1.8 |
| Congestion at the polls | 0.8 | 1.5 | 0.5 | 1.5 | 0.5 | 1.3 | 0.5 | 0.2 |
| Poor location of polling booth | 0.8 | 1.0 | 0.8 | 1.1 | 0.7 | 1.1 | 0.5 | 0.5 |
| Fear of disclosure of age | 0.3 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | ..... | 0.3 |
| *Disbelief in voting:* | | | | | | | | |
| Disbelief in woman's voting | 7.8 | ..... | 11.4 | 1.6 | 11.3 | 2.2 | 2.3 | 18.3 |
| Objections of husband | 1.0 | ..... | 1.5 | 0.1 | 1.6 | 0.3 | ..... | 2.6 |
| Belief that one vote counts for nothing | 1.5 | 1.8 | 1.4 | 1.3 | 1.6 | 1.6 | 1.3 | 1.3 |
| Disgust with politics | 4.3 | 5.1 | 4.0 | 3.4 | 4.9 | 4.9 | 4.2 | 3.5 |
| Disgust with own party | 2.0 | 3.1 | 1.4 | 4.4 | 0.6 | 3.1 | 2.6 | ..... |
| Belief that ballot box is corrupted | 0.7 | 1.1 | 0.5 | 0.7 | 0.7 | 0.8 | 1.6 | 0.6 |

| Reasons for not voting | Total | Sex | | Registration status | | Voting experience | | |
|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Registered | Not registered | Voted in Chicago | Voted elsewhere | Never voted |
| Disbelief in all political action.... | 0.4 | 0.6 | 0.4 | 0.2 | 0.5 | 0.2 | 0.3 | 0.8 |
| *Inertia:* | | | | | | | | |
| General indifference | 25.4 | 14.6 | 30.4 | 11.5 | 33.4 | 17.0 | 16.6 | 41.0 |
| Indifference to particular election.. | 2.5 | 2.6 | 2.4 | 2.8 | 2.3 | 3.6 | 2.9 | 0.3 |
| Neglect: intended to vote but failed.. | 8.4 | 10.9 | 7.3 | 14.5 | 5.0 | 11.9 | 8.8 | 2.8 |
| Ignorance or timidity regarding elections........... | 7.1 | 4.6 | 8.3 | 2.7 | 9.6 | 4.1 | 7.5 | 12.0 |
| Failure of party workers........ | 0.9 | 0.5 | 1.0 | 0.7 | 1.0 | 1.0 | 1.0 | 0.6 |

* Basis of 100 per cent in each case.

† Includes twenty-two cases in which no information regarding registration status was given and thirty-nine cases in which no information regarding voting experience was given.

thors endeavored to secure an exact answer. Fig. IV gives the answer for the distinctions of sex, registration status, and voting experience. The latter portion of the table indicates nothing particularly striking except that of the people who had never voted at all, practically three-quarters gave one of three reasons—general indifference, accounting for two out of five; disbelief in woman's voting, accounting for one out of five; and ignorance or timidity regarding elections, accounting for one out of eight. The first part of the table shows that only women were deterred from voting by disbelief in women going to the polls (this was the reason in the case of one out of every nine women). Accordingly, though many more women have never voted than men, the table indicates that of the women who have never voted, disbelief in their own right of suffrage is about half as strong a deterring factor as general indifference. The other

suggestive results of the table are that between one-fifth and one-quarter of the male nonvoters were absent on election day, that more than one out of eight of the men did not vote through fear of loss of business or wages, and that general indifference and ignorance or timidity about elections operated twice as forcefully to keep women from the polls as to keep men.

The investigators also related reasons for nonvoting to distinctions of color and nativity, racial affiliation, occupation, age groups for both men and women, and the income status of the nonvoters. These results were all significant and suggestive, but enough excerpts from the study have now been given to illustrate the nature and value of such research; accordingly, we shall dispense with further details.

**What is the significance of such results?**

Just what has been accomplished by securing these statistics? Mainly, that we now know something definite and exact about the significant relations of the nonexercise of the suffrage to other facts. The result is meager, for it is based on a single election in a single city, and one could not safely generalize beyond these limits till many other studies of the same sort had been made elsewhere and at other times, but as far as it goes it yields definite and accurate knowledge. And already, as a result of it, we see much more clearly than we ever could have seen otherwise some of the things that need to be done if we wish to increase the exercise of the suffrage. It becomes evident, for example, that better laws concerning sick and absentee votes would help greatly, that the earlier carrying out of Americanization programs with immigrants and their children would make a difference, and that the great deterrent of general indifference toward the duties of citizenship would be greatly overcome by a broader distribution of material prosperity. To know these things, not by guesswork, but with exactitude, is to have made a genuine and substantial beginning toward the scientific treatment of a puzzling social problem.

**Coöperative aspect of the inquiry**

Moreover, by such a survey the ground is broken and a standard and method are set for further studies of the same type of problem—they will find their task easier because of the clarifying light which the present results throw. With fine recogni-

tion, in fact, of the essentially coöperative nature of science, and of the tentative and incomplete character of their own undertaking, Professors Merriam and Gosnell append to their volume a series of explicit suggestions to later inquirers for the rectification of mistakes discovered in their own methods, and for the securing of additional items which might reveal significant correlations, such as facts regarding education and literacy. To make sure that the account of one's scientific studies includes a thorough description of how one pursued them, so that others may detect errors in method or assumption as they appeared; and to add definite suggestions for the work of others based on the lessons learned in one's own experience—these indicate full realization of the implications of the empirical and hypothetical way of scientific advance and of the inherently social significance of every valuable step or discovery.

Study in the stimulation of voting by [illegible]

In 1924 and 1925 Professor Gosnell followed up this research by a new investigation in which it was attempted to determine how large a percentage of the nonvoters would be turned into voters by mailing out a nonpartisan appeal urging them to exercise their rights of citizenship.[1] The group stimulated in this way consisted of a sampling from the entire citizenry of Chicago of about 3,000 people. The investigators tried to make this sample representative, and thus neutralize the inevitable operation of uncontrollable factors affecting voting, by selecting it from twelve districts scattered throughout the city, ranging from the Gold Coast to the negro and foreign colonies, and by distributing the various racial, educational, and propertied differences substantially as they were distributed in the entire city. The control group consisted of about the same number of people distributed in the same way throughout the same districts, and in order to avoid much transfer of the stimulus from the group experimented on to the control group, the representatives of each group in each district consisted of separate and entire but adjacent blocks.

Cards were mailed out at three separate times to the members of the experimental group. The first card was a brief

[1] H. F. Gosnell, *Getting Out the Vote*, 1927.

notice of the necessity of registration, on October 4 or October 14, 1924, if one desired to vote in the November presidential election, with a statement of the location of the recipient's polling booth and of the provision for absentee registration. The notice, mailed a few days before October 4, follows:

Methods of stimulation

NOTICE TO REGISTER

You cannot vote November 4 unless you register now. It makes no difference whether you were registered before or not; you *must register again* if you wish to vote for President, United States Senator, or Governor.

Registration days will be *Saturday, October 4*, and *Tuesday, October 14*. You can register at your polling place on either of those days from 8:00 A.M. to 9:00 P.M. Your polling place is located at.....................

In case you expect to be out of the city on both of these days, you can get your name on the new register by making application at the Election Commissioners' Office, 308 City Hall, any time after October 4 and not later than noon, October 13.

A few days after October 4 a second notice was sent to those members of the experimental group who, it was found from the records, had not registered on that date. These notices were of two different types; one was simply a brief statement reminding the recipient of the fact that he was not yet registered and that he could not vote that fall if he neglected his last chance on October 14, while the other was of a hortatory character, containing a cartoon and several slogans. The cartoon used was a reproduction of one of McCutcheon's cartoons in the *Chicago Tribune,* comparing the nonvoter to the slacker in time of war. The difference between the effect of these two types of notice was later found to be practically negligible in the case of the male registrants, but to amount to about four per cent (in favor of the cartoon) in the case of the women.

On February 24, 1925, an election of aldermen to the City Council of Chicago was held, and another opportunity to register for people who had not registered in October was given on February 3. In order to test out the chances of getting continuous results by a mail canvass, despite some doubts as to whether the

saturation point had not been reached, another notice calling attention to the necessity of registration was sent to the members of the experimental group who had not registered in October. Finally, in order to test the effect of this sort of stimulus on the actual voting of those who were registered, notices which combined a cartoon on one side and rather thorough instructions for voting on the other, were sent before the aldermanic election to the members of the experimental group who were registered.

If, now, we consider these notices in the light of the reasons for nonvoting revealed in the previous study, it will be evident that they might be expected to overcome to some degree all of the factors included under the general head of inertia, especially that of sheer neglect, while they might resist slightly one or two of the other factors, such as poor location of polling booth and disgust with politics. It will be noticed that these factors accounted for between fifty-five and sixty per cent of the cases of nonvoting in 1923.

Results of the stimulation

What influence did these mail notices have upon registration and voting? Roughly, they made a difference of nine per cent in each of the instances tried, except in the matter of registration for the aldermanic election, where six per cent of the experimental group registered as against one per cent of the control group. In other words, the notices overcame the inertia or other restraining causes of about one out of eleven of the people who received them. The exact figures for the four occasions follow in Fig. V.

The data which Professor Gosnell and his assistants had previously secured about each of the members of these two groups made it possible also to chart statistically the relative effect of this type of stimulus upon citizens of specified differences of sex, race, city location, voting record, type of citizenship, race affiliation, length of residence, income, literacy, and educational attainment. The results as regards city location and party preferences seemed to indicate little more than the relative effectiveness of different party organizations in different parts of the city, though it was discovered that such a nonpartisan stimulus made a very remarkable difference in the response of the independent voters with whom the party managers had little

FIG. V

| Registration day | Number of citizens not registered before registration day | | Percentage that registered | |
|---|---|---|---|---|
| | Control group | Experimental group | Control group | Experimental group |
| Oct. 4, 1924 | 2,673 | 2,986 | 33.7 | 42.3 |
| Oct. 14, 1924 | 1,771 | 1,723 | 47.4 | 56.0 |
| Feb. 3, 1925 | 894 | 716 | 1.1 | 5.9 |

| Voting day | Number of citizens registered | | Percentage that voted | |
|---|---|---|---|---|
| | Control group | Experimental group | Control group | Experimental group |
| Feb. 24, 1925 | 1,572 | 2,104 | 47.5 | 56.9 |

to do. Of those who indicated a preference for La Follette, for example, thirty-five per cent more of the experimental group registered and voted than of the control group. The suggestive implications of this are important and obvious.

**Relative influence of the stimulus on different portions of the group**

With respect to each of the other differences significant results were attained. With the exception of the local election, the notices had slightly more influence on women than on men. Of citizens who had never voted before, the notices induced to register or vote eighteen per cent, the figure declining to five per cent for those who had voted regularly before. Of the racial groups the negroes, Scandinavians, English and Canadians, and Italians were influenced much more strongly than others, while the Irish, Germans, and Poles, who were already more accustomed to voting, were influenced much less than the average. As to income differences, the people who paid $100 per month

or more rental seemed to be more influenced than the less wealthy. The notices made seventeen per cent difference in the voting of the illiterates, as compared with nine per cent in the case of those who could read and write English. In the case of other educational attainments the same general result appeared, those of less schooling being influenced to vote much more than those of more schooling, whose voting habits were already comparatively good.

**Value of the result reached**

The study thus gave exact, quantitative information on the effect of a definite type of stimulus in increasing the registration and the vote of Chicago citizens, both in general and in reference to more limited group differences that the previous study had shown to be significant. It indicated at once what might be expected from a more general use of the same type of stimulus, and made it possible to focus more intelligent attention on the problem of devising methods which would have a still larger effect and which would reach other causes of nonvoting than those reached by the method here tried. Professor Gosnell himself summarizes the results of his work under the following four heads:

"First, it is possible by the method of random sampling to measure the success of any device designed to interest people in elections.

"Second, a complete personal notification of all the adult citizens regarding the time and place of registration will secure a more complete listing of all persons qualified and anxious to vote than is obtained at present.

"Third, a complete notification of all the registered voters regarding the candidates and issues to be voted upon would increase the proportion of registrants who voted in all elections.

"Fourth, a civic educational program for adults as well as for children would undoubtedly have an immediate and continuous effect upon the interest shown in elections."

**The theory of probability**

In the above discussion we have had frequent occasion to use the conception of probability, assuming a general knowledge of its meaning on the part of the reader. Textbooks of logic have usually devoted a chapter to a systematic exposition of the main

principles by which reasoning in terms of probability must be guided. So far, however, as these principles permit logical exactitude, they really constitute a branch of mathematics, and there is no more reason why they should be discussed here than any other branch of mathematical science. If a coin has two faces, and each is equally likely to fall uppermost, then the probability in a given toss of either heads or tails is ½; that is, it is the ratio between the outcome favorable to our desire and the number of possible outcomes. The whole mathematical theory of probability is a deductive development of the corollaries of this ratio under conditions of varying complexity. Its use in statistics is relatively simple, as we see from the above.

**Non-mathematical probability exemplified in circumstantial evidence**

But there is a form of probable reasoning that cannot be expressed with mathematical precision, to which it will be pertinent to devote a paragraph, for we frequently have to use it in dealing with concrete problems. This form is most interestingly exemplified in dealing with circumstantial evidence. The prisoner at the bar is charged with arson, resulting in the destruction of his neighbor's house. There is no direct testimony to his guilt, but some definite circumstances point strongly in that direction. He had been known to hold a strong grudge against the injured neighbor, which had been inflamed anew on the day preceding the crime. He was absent from home at the time the fire began, and footsteps leading away from the burned building were such as might have been made by the shoes he was wearing. On the other hand he had been hitherto a man of law-abiding reputation, and steadfastly maintains his innocence, though an alibi could not be established by direct testimony that he was elsewhere at the time of the fire.

**Principles by which we reason in such cases**

Two questions now arise for public opinion and the law to deal with. First, is his guilt the most probable explanation of the event? Second, is it so probable that he may properly be convicted and punished for the crime? How are we to proceed to answer these questions? Obviously, the fundamental source of the difficulty is to be found in the extreme complexity of the situation, combined with our inability to state with confidence just how much weight is to be attributed to each of the relevant

circumstances. More exact social science would doubtless help on this latter point, but as long as it failed to give precise knowledge of individuals as individuals it would not overcome entirely the haze that surrounds our thinking on such problems. Accordingly, the best general principles that can be set up to guide our thinking have to be left in very broad and generous form; we know how possible it is for a number of circumstances to point toward a quite innocent person. With reference to the first question we may see no likely alternative explanation, and may therefore hold in reserve a certain suspicion, while agreeing that so far as it is socially safe the suspected individual ought to be given the benefit of the doubt. And this means, as to the second question, that we hesitate to impose conviction and punishment unless all the relevant circumstances converge so unmistakably upon the accused that there is no reasonable doubt whatever of his guilt. In the above case, for example, should it be shown in addition that the suspected individual had threatened to burn the house, that a knife dropped near the scene was his, and that he had been seen carrying inflammatory material in the direction of the house, nobody would have any real doubt that he was guilty. In short, a considerable number of circumstances all converging in the same way may carry complete conviction, while no one of them singly would be convincing at all. But no rule can be laid down as to how many are necessary or what value should be assigned to each; every case has to be examined on its own merits as well as in the light of general experience.

EXERCISE.—Since the discovery of correlation coefficients and the summing of statistical data are mathematical processes simply, it has been deemed advisable to concentrate in these exercises on the logically more important problems of planning a statistical investigation—deciding what data shall be secured and how it can most effectively be gained. If the instructor or student desires, specific correlations may be worked out also.

1. Suppose you desired to compare the beliefs and practices with reference to Sunday observance in a typical country community of your state with a typical city community. How would you conduct the inquiry?

2. How long, in your community, does it take a new scientific discovery of some method of treating disease, to become generally accepted and used? What are the main factors that aid and hinder the process, and how strong is each?
3. What are the differences, in attitudes, customs, and feelings toward family relationship, between a Chinese village and an American village comparable in as many other respects as possible?

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## CHAPTER THIRTEEN

# PRINCIPLES OF SCIENTIFIC PROGRESS

Problem of the chapter

IN CHAPTERS nine to twelve inclusive, our main purpose has been to clarify the reflective significance of scientific method and to examine the principles and procedures by which single laws of connection or correlation are verified. But there are several highly important characteristics of scientific method which can hardly be adequately revealed in this way. One is the manner in which, historically, less exact modes of scientific definition and generalization tend to be replaced by more exact functional modes, through the growth of a more eager scientific curiosity and the appearance of geniuses who discover concepts in terms of which events which had been previously studied in loose qualitative terms become amenable to exact mathematical treatment. Another is the extent to which fruitful scientific advance is necessarily a coöperative enterprise, each investigator building upon what his predecessors have achieved and stating his own problem in the terms which their researches have helped to define and their interests have made central. Parallel with these processes, of course, goes a growing emancipation from unscientific assumptions, and the application of scientific results to the invention of material instruments, some to use in processes of experimentation and some to control nature in more generally serviceable ways. Furthermore, there are certain important principles, not hitherto discussed, such as the principle of parsimony in the statement of scientific law, whose function is very important in determining the selection of alternative points of view for the organization of accumulated masses of fact. In general, we need to examine with considerable care the process by which the rather scattered scientific results of one age tend to be in-

corporated within a more inclusive system set up and verified by a later genius, the separate relations or correlations of the one becoming alike functions of a more general and underlying law in the other. Since in these characteristics, as well as in those already discussed, science represents reflective thinking at its most highly developed level, we must not omit treatment of these aspects of scientific procedure. The history of science is the romance of intelligence struggling to master its world, and some of the chapters of scientific progress could, by a literary genius who had caught the vision of the scientist, be made no less thrilling than a novel.

**These principles illustrated by the astronomy and mechanics from Copernicus to Newton**

The present author does not intend to compete at such romantic portrayals, but a discussion of those features of scientific method just named can hardly be done otherwise than by a somewhat extended analysis of a definite course of events in the history of science, lengthy enough and reaching a sufficient degree of unity so that these larger lessons may become evident. For this purpose we shall select the history of astronomy and of mechanics from Copernicus to Newton, concentrating particularly on the discoveries which came to be summed up in the latter's law of universal gravitation. The individual contributions will be presented in sufficient detail so that the essential steps of this entire chapter of science will be brought out, with the exception of certain mathematical discoveries whose detailed statement requires a background of the higher mathematics.

**Pre-Copernican assumptions**

As everybody knows, prior to the publication of Copernicus's famous work *On the Revolutions of the Celestial Orbs* in 1543, it was a practically universal belief in Europe that the earth was the center of the universe, sun, moon, and stars revolving round it. Certain of the early Pythagorean philosophers and a few later investigators, such as Aristarchus of Samos, had suggested a motion of the earth, or even a solarcentric system, but these suggestions had not been taken seriously by other astronomers, and Ptolemy's ingeniously worked out geocentric scheme had in its general outline become authoritative between his time (the second century A. D.) and that of Copernicus. But this belief, of course, was held with varying degrees of superstition or sophisti-

cation. Most of the ignorant common folk thought of the earth as a flat disk surrounded by the ocean, with a dangerous edge from which a careless sailor might easily topple off into space, and covered by an inverted blue bowl to which the stars were attached. The cultured knew that the earth was round, for various observations and experiments by ancient astronomers had made that fact clear. For most of these sophisticated folk Ptolemy's merely geometrical scheme for describing the observed motions of the heavenly bodies, on the assumption that the earth was at the center, had been complicated by the notion of a system of revolving crystalline spheres to which these bodies were attached, a notion probably originated by a pupil of Plato named Eudoxus and, with some changes, consecrated by the authority of Aristotle. At the time of Copernicus these spheres varied somewhat in number in different authors; rather typical is the scheme in Apian's *Cosmographia* which pictures ten spheres. The moon is attached to the first, Mercury to the second, Venus to the third, the sun to the fourth, Mars to the fifth, Jupiter to the sixth, Saturn to the seventh, while the eighth constituted the firmament of the fixed stars. A ninth was added to account for supposed changes in the position of the ecliptic, and the tenth was the primum mobile, which communicated their proper motion to all the others, and was itself moved by the direct power of the deity, who, together with the elect, inhabited the empyrean which surrounded it. Of course even such a complicated scheme did not adequately account for more than a few of the observed astronomical facts.

Why the geocentric belief?

What were the main reasons which induced people to believe so readily that the earth was the center of the universe? Some were, of course, religious reasons, connected with the Christian philosophy of history and man's proneness to suppose the drama of his life of exceptional importance in the universe. Others were the natural tendency to take as our center of reference the most stable thing in our immediate neighborhood, and certain empirical facts which had been made the basis of a rough but comprehensive physical science. Empirical observation had analyzed the physical world into four orders of substance—earth,

water, air, and fire. Some added a fifth substance, the ether, which pervaded and surrounded the other four. Now to empirical observation, of course, the earth is by far the most solid, heavy, and stable of these substances. Massive, hard, and firm, it is not readily put into motion by any external force, but remains an almost unyielding foundation for the various processes of change. Water is not quite so heavy, solid, or hard. It is more pliant and plastic to the play of forces, as we see in the flow of the river and the waves or tides of the heaving sea; accordingly, it seeks its proper place above and around the earth. Next in order comes air, which is still lighter and more easily stirred in motion, as every passing breeze and mighty wind tell us; its place is therefore to surround water and earth at their upper limit. Fire, evidently, is the lightest and most mobile of these four substances. In every flickering flame or roaring conflagration we see how incessantly its parts are in violent motion, and how desperately they struggle to reach their proper place above the air which incloses them. The true home of fire is accordingly to be found in the upper reaches of the universe, where the sun, moon, planets, and stars are in their proper element and able to pursue regular and placid courses around the firmament. For to the senses these objects appear to be simply disks or spots of fire, and before the invention of the telescope it is hardly to be expected that more than a very occasional hardy speculator would entertain the supposition that they were made of the same substance as the earth, or more than the minutest fraction of its size.

**Objections to the notion that the earth moves**

In this background of thought about the physical structure of the universe, based as it was on a rough and unaided commonsense observation of things, it is obvious how thoroughly natural and consistent was the conception of the earth as the center of the universe, and how very radical and unnatural would be the suggestion that the earth really moves round the sun. The most evident objection to the hypothesis that the earth moves was expressed by Ptolemy himself when he said, "If there were motion it would be proportional to the great mass of the earth and would leave behind animals and objects thrown into the air." In the

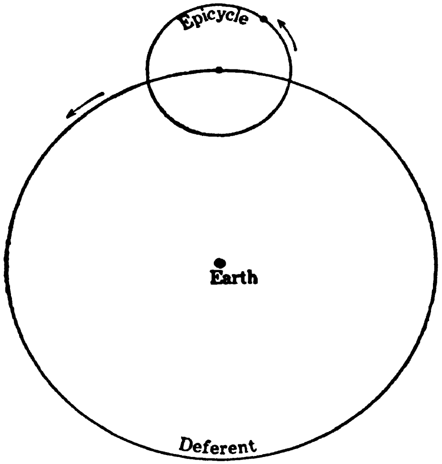
absence of even the first foundations of our modern theory of dynamics, how could such an objection be adequately answered? For those who believed in the crystalline spheres, to be sure, the same point might be made about them, as Copernicus noted —how could such huge structures revolve so rapidly as they do without flying to pieces? But that these spheres were surrounded and ultimately controlled by the omnipotent power of God was a sufficient answer for most. Accordingly, the picture of things enforced by the entire intellectual atmosphere of the age was that of the solid earth resting immovable at the core of the world, covered by a partial layer of water and a complete one of air, while at a greater distance these bits of starry flame were gently swept about it day by day through the light ether, their genial light and ordered courses testifying to the providential love and dependable power exerted upon them through the primum mobile by the Divine Creator, who embraced all in His everlasting presence.

How Copernicus's problem originated

How was Copernicus induced to contest this hoary and appealing scheme? Did he do so by breaking all at once from its presuppositions and turning to a quite novel point of view? Not at all. As the student who has followed the earlier chapters of the present book with understanding will fully realize, none of us can ever jump out of ourselves in such a fashion. We may formulate somewhat novel problems, but the formulation is always in terms of currently accepted knowledge. Moreover, the problem itself is apt to take the form at first of a conflict between traditional authorities, only gradually developing a more radical significance as it forces minds that seek consistency in their ideas to break free from authority and consider the issue anew.

That this was the case with Copernicus is the primary point to note in the way in which his difficulty took shape. The original suggestion, apparently, that started his mind at work, was that the complexity of the geometrical representation of astronomical data that Ptolemy had been forced to work out, was inconsistent with the dependence of the motions upon God. The ultimate divine cause is single and uniform in his modes of operation; the universe ought to reveal, therefore, the function-

ing of simple and harmonious laws. But instead it is such a cumbrous and intricate affair (as explained by the accepted scheme) that one is tempted to remark, as the Spanish prince is said to have done to his tutor, "If I had been present when the universe was made I should have seen to it that it was made much more simply." The fact is that by the time of Ptolemy such extensive observations of astronomical data had been made that no way of accounting for the facts on the assumption that the earth is at rest had presented itself which was not a pretty



PTOLEMY'S SCHEME OF DEFERENTS AND EPICYCLES.

complex affair. The best technique that Ptolemy had devised to deal with this situation was a system of deferents and epicycles. An entirely uniform motion around the earth as center could of course be represented by a single circle, but if there were variations from uniformity such a representation would not do. To account for variations, Ptolemy found it convenient to suppose that the earth was the center of an invisible circle called a deferent, and that the planet moved on the circumference of another circle, the epicycle, whose center was carried around at uniform velocity on the circumference of the deferent. By selecting suitable velocities and radii for these deferents and epi-

cycles, Ptolemy was able to represent most of the observed irregularities of motion with considerable success. For some irregularities, indeed, he used a somewhat different scheme of equants and eccentrics, but these we need not take the space to describe. But the total number of epicycles needed to represent the data by this method was very large—seventy-nine in several standard interpretations of his system—and that there should be any irregularities at all seemed to Copernicus inconsistent with the unitary and perfect nature of their divine author. Any want of uniformity in motion, he says, "must arise either from irregularity in the moving power . . . or from some inequality of the body in revolution. . . . Both of which things the intellect shrinks from in horror, it being unworthy to hold such a view about bodies which are constituted in the most perfect order." [1] His mind became open, accordingly, to some hypothesis that might explain the data without falling afoul of this inconsistency.

Recognition of the relativity of motion

The next point which seems to have become clear to him, perhaps after beginning some of the reading to which reference will soon be made, was that motion, after all, is always a relative conception. The apparent motion of the sun from east to west, for example, indicates fundamentally nothing more than a certain change in the relative positions of the sun and ourselves. We tend naturally to think of our own position as at rest, and attribute the motion to the sun, but the mere fact of the change which we observe does not need to be accounted for thus; it might equally well be explained by supposing the sun at rest and attributing a revolution of the earth on its axis from west to east. No observed astronomical motion by itself, in other words, indicates decisively an answer to the question whether the motion should be attributed to the object observed or to ourselves.

> For all change in position which is seen is due to a motion either of the observer or of the thing looked at, or to changes in the position of both, provided that these are different. For when things are moved equally relatively to the same things, no motion is perceived, as between the object seen and the observer.[1]

[1] Quoted in A. Berry, *A Short History of Astronomy*, p. 101.

These suggestions were pretty radical, however. Copernicus needed external encouragement to pursue them further; moreover, he, like the rest of us, could not generate a solving hypothesis out of nothing.

Help derived from ancient astronomers

Wherefore, [he says], I took upon myself the task of rereading the books of all the philosophers which I could obtain, to seek out whether anyone had ever conjectured that the motions of the spheres of the universe were other than they supposed who taught mathematics in the schools. And I found first that, according to Cicero, Hicetas had thought the earth was moved. Then later I discovered, according to Plutarch, that certain others had held the same opinion. . . .

When from this, therefore, I had conceived its possibility, I myself also began to meditate upon the mobility of the earth. And although the opinion seemed absurd, yet because I knew the liberty had been accorded to others before me of imagining whatsoever circles they pleased to explain the phenomena of the stars, I thought I also might readily be allowed to experiment whether, by supposing the earth to have some motion, stronger demonstrations than those of the others could be found as to the revolution of the celestial sphere.[1]

As he expresses the matter in his little *Commentariolus,* written about 1530, thirteen years before the publication of the *De Revolutionibus*:

So when I had noted these things, I often considered if perchance a more rational system of circles might be discovered, on which all the apparent diversity depended, and in such a manner that each of the planets would be uniformly moved, as the principle of absolute motion requires. Attacking a problem obviously difficult and almost inexplicable, at length I hit upon a solution whereby this could be reached by fewer and much more convenient constructions than had been handed down of old, if certain assumptions, such as are called axioms, be granted me.

Making, then, the hypothesis that the sun and the fixed stars should be taken as at rest and that to the earth should be attributed, first a daily revolution on its axis directed toward the pole star, and second an annual revolution around the sun in an orbit located between the orbits of Venus and Mars, Copernicus proceeded to a careful examination of the known astronomical data to see whether from that point of view the motions would become more simple and uniform. The outcome was, of course,

Verification of the new hypothesis

[1] Copernicus, *De Revolutionibus,* Letter to Pope Paul III.

that they did gain greatly in simplicity and harmony when viewed in terms of this hypothesis.

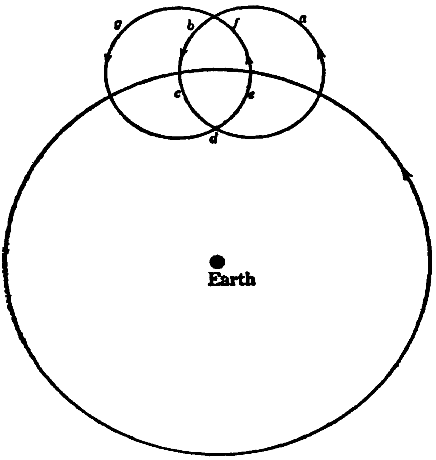
Thus, supposing these motions which I attribute to the earth later on in this book, I found at length by much and long observation, that if the motions of the other planets were added to the rotation of the earth and calculated as for the revolution of that planet, not only the phenomena of the others followed from this, but also it so bound together both the order and magnitude of all the planets and the spheres and the heaven itself, that in no single part could one thing be altered without confusion among the other parts and in all the universe.[1]

The most interesting fact that from the geocentric point of view challenged explanation without receiving any, was the fact that the radius of the epicycle of each of the superior planets (Mars, Jupiter, and Saturn), which Ptolemy had been forced to invent to represent their so-called retrograde movements,[2] was always parallel to the straight line joining the earth and the sun, so that this epicyclical motion was completed in exactly a year. From the solarcentric point of view this became beautifully explained, the irregularities from our point of view being shown due to the changes in our own position in the earth's orbital movement, so that when this movement is recognized such irregularities entirely disappear and are replaced by a system of fairly uniform motions round the sun as center. Copernicus was able to show also that enough other irregularities were eliminated by attributing these motions to the earth so that the total number of epicycles needed to chart the astronomical data were reduced from seventy-nine to thirty-four. That he was not able to eliminate more was due mainly to the fact that he never questioned the assumption coming down from Greek times that all astronomical motions must be circular. This was a metaphysical assumption justified by the great Greek philosophers as alone consonant with the purity and perfection of the celestial order intermediate between deity and the ugly evils of terrestrial existence, and it became riveted still more firmly by the religious

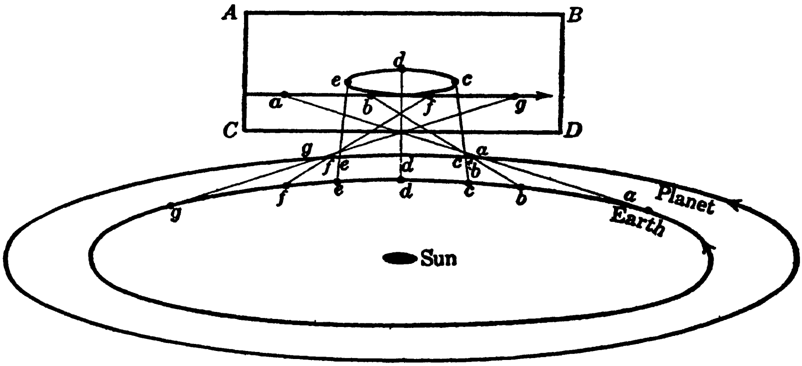
[1] *Ibid.*

[2] The usual motion of a planet among the stars is in the same direction as that of the sun and the moon. For short periods, however, it moves in the reverse direction. Its motion at these periods is called retrograde.

cosmology of the mediævals. But it was a great gain to have achieved as much a reduction as this of Ptolemy's complex geometry of the heavens, and on the ground of the greater simplicity and harmony secured by the solarcentric point of view Coper-




RETROGRADE MOTION AS PRESENTED BY PTOLEMY.
Period of retrograde motion is *cde*.




RETROGRADE MOTION AS REPRESENTED BY COPERNICUS.
*ABCD* is a portion of the celestial hemisphere, against which the planet appears to move.

nicus offered it as the true picture of the astronomical data. We may sum up his thinking thus: Since all motion is relative to the

chosen point of reference, and since a unitary and perfect being is the creator and direct mover of the cosmic scheme, that point of reference should be chosen in terms of which the facts are reducible to the greatest simplicity and harmony possible. This means that the sun rather than the earth is to be placed at the center.

Copernicus's answer to objections

How did Copernicus meet the tremendous difficulties which stood in the way of this hypothesis from the standpoint of the general intellectual convictions of his age? For there were a host of such difficulties. There was the same type of difficulty that Ptolemy had noted. People asked, "If the earth is in rapid motion, how is it that an object projected vertically from its surface does not fall far to the west of the point of projection?" Copernicus could only answer that there were forces emanating from the earth which both attracted surface objects to it, and somehow swept along birds and other objects in the air with the same general velocity as that of the earth itself; the true answer could, of course, only be given when the foundations of dynamics had been laid by Galileo. There was the difficulty that the fixed stars appeared always in the same relative positions, whereas if the earth traverses vast distances through space in its annual orbit the stars ought to appear in somewhat different positions today from those which they occupied six months ago. Copernicus could only answer this objection by saying that the stars are at such enormous distances from us that while they do reveal such a parallax it is too small for us to observe. In course of time this was shown to be the true answer, for in 1838 the astronomer Bessel discovered such a parallax in the case of a few of the stars nearest the earth, a change of position amounting (to the naked eye) to the diameter of a penny at a distance of three miles. But in Copernicus's day this meant attributing a vastness to the sphere of the fixed stars such as seemed ridiculously fantastic. The greatest difficulty of all, however, lay in the general background of accepted physical and metaphysical knowledge. It upset the whole traditional scheme of the hierarchy of substances, earth, water, air, and fire, in their relative differences of weight, mobility, and position, to suppose seriously that

the solid and heavy earth was actually revolving like a planet around a piece of fire like the sun, and the entire anthropocentric scheme of thinking so foundational to the religious interpretation of history was likewise jeopardized.

Adoption of the Pythagorean metaphysics

Copernicus met this kind of difficulty by turning to an alternative physical and metaphysical background, which fortunately had recently undergone a considerable increase of influence. This was the ancient Pythagorean doctrine of the universe as ultimately composed of numbers, by which the Pythagoreans meant, living in an age when geometry and arithmetic had not yet become entirely disentangled, minute figured portions of space. In accordance with this conception, all the four kinds of substance, even the heavy earth, were supposed to be reducible to spatial atoms, the figure and mode of union of the latter determining the appearance and mode of behavior of the substance in question. This notion had been worked out in detail by several ancient thinkers, Plato giving classic form to it in his famous dialogue, the *Timæus*. Obviously, this scheme offered the possibility of justifying a quite different physical science from that which had seemed so securely and empirically based. The Pythagoreans, too, had been interested in the mathematical harmony to which this notion equated the universe. Moreover, if the sun and the earth are both made of the same elements ultimately, and the sun is big enough in size, it becomes quite possible to conceive of the former being really no more heavy or stable than the latter, and accordingly quite as likely to revolve around it as to be the center of its orbit. In other words, this Pythagorean metaphysic offered a set of assumptions that not only did not definitely contradict the supposition that the earth moves round the sun, but also offered some positive support for the guiding principles of simplicity and geometrical harmony which Copernicus was convinced on theological grounds must be revealed in the astronomical motions. If the world is composed of number, and reveals an ultimate mathematical harmony, then surely the Ptolemaic scheme with all its complexity and irregularity would be far less likely to be true than the solarcentric scheme which banishes more than half the irregularities

and introduces harmony of motion in many parts of the cosmos where it had been impossible to introduce it before.

Now we happen to know that this Neo-Pythagorean revival was mainly centered south of the Alps in the later fifteenth century, and that Copernicus not only spent many years there in the last decade of that century, but that his favorite teacher at Florence, Novara, was an ardent Pythagorean and had already discarded the cumbrous Ptolemaic astronomy on account of its irreconcilability with Pythagorean principles. Copernicus thus found with Novara precisely the encouragement as well as the metaphysic that he needed to support him in his break from the accepted cosmology in all its branches. He had no new facts to give empirical confirmation to his new doctrine, but resting firmly on his theological idealism and pinning his faith against the accepted current, on the Pythagorean world-view, he found the solarcentric scheme more generally consonant with everything of which he was most certain, and hence he was willing to stake himself on its adoption.

The observed facts were explicable on either view. But the solarcentric view gave a reason for facts which on the geocentric view were accidental coincidences; others it explained in terms of fewer and less complicated constructions. Granted the shift just noted in the assumed metaphysical background, it seemed more in accordance with the empirical data while contradicting none. Finally it harmonized better with those aspects of religious doctrine which to Copernicus seemed most fundamental.

Principles involved in Copernicus's procedure —empiricism and parsimony

From the standpoint of Copernicus's later scientific successors this last point, which was the primary factor in causing his difficulty with the Ptolemaic astronomy, would be the least significant one. Doubtless it would always play a part, for whenever a scientist is forced to select between two views which from the standpoint of merely scientific considerations are evenly balanced, his extra-scientific interests could hardly help influencing his opinion as to which is most probable. In Copernicus's day, moreover, theology and science had not yet become separated. But the other considerations noted have entered vitally into the theory and practice of scientific method. The first

and absolute requirement, of course, of a sound hypothesis from the standpoint of sound science is that it be shown consistent with all the facts. This is what is meant by the *empiricism* of science. The second requirement is that it be based on the fewest assumptions necessary to make it consistent with the facts. This principle is known as the *law of parsimony,* and was first formulated by William of Occam in the famous scholastic rule, "*Entia non sunt multiplicanda præter necessitatem.*" Let us examine the nature and ground of this assumption. Copernicus's interpretation of it was essentially theological in character, yet he was resting upon the right assumption when, noting clearly the relativity of the astronomical motions, he insisted that that center of reference was to be taken in terms of which the facts could all be accounted for on the fewest postulates. For, other things being equal, why should we insist on a complex explanatory scheme when a simpler one will do just as well? Why leave the annual epicyclical orbits of the superior planets in mysterious separation when by taking the sun as center of reference they can all be seen to follow from the annual revolution of the earth around it? We shall have occasion to return to this principle of parsimony again when we come to Newton, and none of the larger movements in the history of science can be understood without recognizing the necessary place which it plays in scientific thinking. The world as science conceives it is always the most unified and harmonious system that can be conceived consistently with the known facts. To explain a single fact is to relate it to another; to explain a mass of facts is to derive them from the fewest ultimate assumptions possible.

**Meaning of scientific positivism**

In the third place, no dogmatic system of ideas is to be permitted to interfere with the establishment of a new scientific theory, for if that theory conforms to the principles above noted, it is always possible to replace such a traditional metaphysic by another just as inherently plausible and more favorable to the new conception. This principle when combined with the primary insistence on conformity with observed fact, may be called the *positivism* of scientific method. The guiding thought here is simply that preconceived cosmologies may never assume

priority to the conclusions dictated by the principles of empiricism and parsimony, but that we should always be ready to revise them or replace them by alternatives in accordance with these principles.

Conformity of these principles with the purpose of scientific thinking

How difficult it was historically for even a few men to realize these principles with perfect clearness is shown in the halting way in which they are present in Copernicus's thinking; still more evident is it in the struggles of Galileo and Newton to persuade their contemporaries of the validity of such rules of scientific procedure. Their conformity is evident, however, with the fundamental demands of objective, verifiable thinking. To be objective and verifiable by others thinking must be empirical; if its results are to be unified so that they can be brought to bear confidently on the largest variety of future problems, the principle of parsimony must be respected; if finally it is to deal freely with real difficulties, not allowing itself to be chained by the over-beliefs erected on the basis of past interpretation of fact, it must be positivistic. Copernicus was thus learning the fundamental lessons of scientific method itself.

Contribution of Tycho Brahe

The next thinker to whom we turn is Kepler. Born in 1571, nearly thirty years after Copernicus's epoch-making book was published, he became an adherent of the new astronomy while studying under Mästlin at Tübingen in the late 'eighties, and after some years of teaching high-school mathematics at Gratz, he joined Tycho Brahe, the great Danish astronomer, a few months before the latter's death in 1600. Tycho Brahe was not an important new theorist in astronomy, rejecting both Ptolemaic and Copernican schemes in favor of an unsatisfactory compromise of his own, in which the other planets were supposed to move round the sun, while the latter moved round the earth. It is interesting to observe that this view retains most of the advantages which Copernicus had secured by applying the principle of parsimony, while at the same time conforming to the prevalent physical assumptions. The main reason why it became unsatisfactory is to be found in its inconsistency with the new foundations of mechanics soon to be laid by Galileo, while the Copernican theory proved not only consistent with, but re-

quired by, the main laws of mechanics. But Tycho's greatness lay in the number and exactitude of his astronomical observations, of which Kepler gained possession after his death, and which set an entirely new standard of precision in recording the positions of the heavenly bodies. Gaining from the king of Denmark large financial grants and possession of the little island of Hveen, Tycho had in 1576 built a splendid observatory equipped with the best instruments that could then be devised or secured. Realizing the importance of exact observations, he had himself invented some new mechanical devices which were far superior to anything previously existing. Among these were large fixed instruments, capable of restricted motions only and therefore much more steady than instruments which could be pointed to any part of the sky, specially constructed sights to aid the eye, and a method of graduating his instruments by transversals, which increased the accuracy of the record. Moreover, he formed the habit of taking a number of observations of the same star under different mechanical conditions, so as to allow for the imperfections of his instruments, and of taking observations from different positions to permit correction of the displacement due to the refraction of the atmosphere. With these aids Tycho built up a star catalogue and bequeathed a vast record of observations, so much more exact than anything previously available that it was now possible for the first time to test mathematical theories in astronomy by the data with considerable confidence. The places assigned by Tycho to the nine stars which were fundamental in his catalogue differ from their positions as determined by the best modern observations by angles which in most cases are less than one minute, only one difference being as high as two minutes, whereas the most accurate previous catalogue was apt to err as much as several minutes in any given observation. In fact, Copernicus was so inferior to Tycho in such calculations that his deduction of the position of one star, whose location was of special importance because extensively used by him as a standard of reference, was in error nearly forty minutes, one-third more than the apparent breadth of the sun or moon. It was accordingly highly

fortunate for Kepler that he fell heir to Tycho's magnificent results, and had, moreover, acquired in association with the Danish observer a sense of empirical responsibility and unswerving loyalty to fact as revealed by exact observation.

Vagaries of Kepler's thinking

For the curious vagaries of Kepler's character we shall be prepared by remembering the extent to which Copernicus's thinking was imbedded in the prevalent assumptions of his time. Kepler combined with his passion for the discovery and exact verification of mathematical laws in the field of astronomy such superstitious notions as a belief in sun-worship and in the validity of astrology, and allowed himself to run wild in a number of mystical theological speculations. These do not, of course, detract from the value of his real astronomical achievements; they simply indicate how impossible it is for even the best thinkers of any age to free themselves from all the unwarranted notions that are prevalent around them. We come to question or reject only those inherited beliefs that have aroused suspicion, and in no normal man's life will there be time enough for all his early ideas to come under suspicion and criticism. Now Kepler's main problem, which led to his constructive work, can be stated in terms that show its complete continuity with the original problem of Copernicus. There is the same theological grounding of his conviction that the universe must compose a simple and regular system, there is the same acceptance of the Pythagorean metaphysical background in preference to that of Aristotle, and there is in him in greater degree the æsthetic delight in mathematical harmony which had had some influence on Copernicus and plays some part in the thinking of every exact scientist. The latter factor is revealed in such a quotation as the following:

> I certainly know that I owe it [the Copernican theory] this duty, that as I have attested it as true in my deepest soul, and as I contemplate its beauty with incredible and ravishing delight, I should also publicly defend it to my readers with all the force at my command.[1]

His guiding problem

Sharing this common background of general assumptions with Copernicus, Kepler's guiding thought took the following form: If the Copernican system is true, there must be many other mathe-

[1] *Opera,* VI, 116.

matical harmonies in the celestial order that can be discovered by developing its consequences, and which would not be consistent with the Ptolemaic cosmology. Copernicus had reduced the epicycles to thirty-four; perhaps it might be possible to reduce them still more by following other leads, and to lay bare harmonious mathematical relationships deducible from the new scheme such as his great predecessor had not conceived at all. Accordingly, with Tycho's exact observations to use in testing his hypotheses, it became the passion of Kepler's life to penetrate, for the "fuller knowledge of God through nature and the glorification of his profession," these deeper harmonies. That he was not satisfied, as so many of his contemporaries were, merely with mystical manipulation of numbers or æsthetic contemplation of geometrical fancies, but insisted on precise confirmation of his formulæ by the data, we owe to his training in the best traditions of mathematics and astronomy, and in considerable degree to the influence of Tycho, characterized so vigorously as the latter was by eagerness for exact empirical facts.

Futility of many of his results

It is natural, then, that Kepler, approaching his problem in this manner, should discover a great many harmonies in the astronomical data which were of no value whatever for the purposes of later science when it had become more wary of the mystical and æsthetic fancies which bulked so large to him, along with some few which were of the highest significance for subsequent thinkers. For any sort of mathematical order which could be deduced from the Copernican system while being irreconcilable with the geocentric view, was of equal value to him, since it showed the former to be in harmony with the general Pythagorean assumption of the universe as an order of intricate geometrical configurations. As illustrating the type of result over which he showed great enthusiasm, but which was of not the slightest value for subsequent astronomy, we may cite the discovery published in his first volume in 1596, a portion of the title being translatable as *The Forerunner of Dissertations on the Universe, Containing the Mystery of the Universe.* This consisted of a geometrical relation between the distances of the several planets from the sun and the five regular solids—that

is, the solids whose faces are equilateral and equiangular. Kepler found, after a long course of ingenious theorizing, that the distances between the orbits of the six planets then known bore a certain rough resemblance to the distances which would be obtained if the hypothetical spheres to which the ancients imagined the planets affixed were inscribed in and circumscribed about the five regular solids properly distributed between them. Thus if a cube be inscribed in the sphere of Saturn, the sphere of Jupiter will approximately fit within it, then between Jupiter and Mars the tetrahedron, between Mars and the earth the dodecahedron, between the earth and Venus the icosahedron, and finally between Venus and Mercury the octahedron. Of course, later astronomy has found no use for this performance; it reflects the mystico-mathematical background of Pythagoreanism rather than the experimental-mathematical point of view of modern science. Moreover, the correlation that Kepler was able to secure was very rough, and the discovery of new planets has upset its guiding principle. But Kepler was immensely pleased with this achievement, and for many years referred to it as his most important claim to distinction. In a letter written shortly after the discovery he wrote: "The intense pleasure I have received from this discovery can never be told in words. I regretted no more the time wasted; I tired of no labor; I shunned no toil of reckoning, days and nights spent in calculation, until I could see whether my hypothesis would agree with the orbits of Copernicus or whether my joy was to vanish into air." [1] By this theory he had explained, as he believed, why it was that the planets were six in number.

But this was before Tycho's restraining influence began to exert itself on Kepler. After 1600 he managed to guide his thinking into somewhat more fruitful channels. Not that he gave up the search for mathematical harmonies in the universe wherever he could find them—in his last great work, the *Harmonices Mundi*, published in 1619, we see him engaged in a laborious attempt to reduce the music of the spheres, taught by the ancient Pythagorean tradition, to precise laws, and to express it in our

[1] Quoted in Oliver Lodge, *Pioneers of Science*, ch. iii.

form of notation—but he happily managed to devote some of his energy to problems concerning the relations between the velocities and distances of the planets, and the harmonies he discovered here were indispensable to the later work of Newton. While, therefore, scores of the interesting mathematical relations which he established were of no value to an age which had outgrown the mystical aspect of his Pythagoreanism, either as verification of the solarcentric view or for any other purpose, three of them became of the greatest value in the onward march of science.

**Investigation of the planet Mars**

That Kepler was interested in the problems leading to the discovery of these three was, however, quite in line with the major presuppositions which he shared with Copernicus. It was the inconsistency of the observed irregularities in the planetary motions with the single and never-failing divine cause of their revolution, that was the constantly prodding perplexity to each of them. By hypothesizing the sun as the center of the system, Copernicus had been able to reduce these irregularities, but many of them still challenged explanation. Due to the ancient assumption that the circle is the only perfect form of curve, most of these challenging irregularities consisted of deviations from uniform circular motion. Now these deviations differed greatly in amount in the different planets, being especially large in the case of Mars and of Mercury. Observations on Mercury were still, however, rather few in number, due to its proximity to the sun, while Tycho had made an abundant series of very careful observations on Mars. Accordingly, Tycho himself had assigned the latter planet to Kepler for special study, and after Tycho's death, during much of the first decade of the seventeenth century, Kepler devoted himself to the most painstaking theorizing and testing, in the endeavor to reduce the Martian deviations to some regular law.

**Preliminary difficulties solved**

Copernicus had set up a system of epicycles to account for Mars's orbit, but these proving inconsistent with Tycho's observations, Kepler set himself to devise other schemes. The first serious difficulty that had to be overcome was that, from the Copernican standpoint, every observed position of Mars was a

result both of the motion of Mars and that of the earth in their respective orbits round the sun, and since both orbits showed irregularities, how could those due to the motion of Mars alone be wholly disentangled from those due to the motion of the earth? After many attempts, Kepler finally found a way of combining observations made at suitable times of both the sun and of Mars, which made it highly probable that certain irregularities were of the earth's motion solely, and the others due solely to Mars. Having thus isolated the latter, he was ready to entertain and test suggested explanations of them. For a long time, as was natural, the hypotheses that he considered were of the traditionally accepted type—that is, combinations of epicycles, equants, or eccentrics; he laboriously deduced by mathematical calculation the results of each and then carefully compared them with Tycho's observations. At one stage he arrived at a geometrical combination which was able to represent the observations with errors no greater than eight minutes. Here was a temptation to Kepler's exactness and empirical loyalty which he was fortunately able to resist.

> Since the divine goodness [he said] has given to us in Tycho Brahe a most careful observer, from whose observations the error of eight minutes is shown in this calculation . . . it is right that we should with gratitude recognize and make use of this gift of God. . . . For if I could have treated eight minutes of longitude as negligible I should already have corrected sufficiently the hypothesis.[1]

But an error of as much as eight minutes in a planetary observation by Tycho was quite impossible, hence in faithfulness to fact the scheme had to be given up.

Discovery of the planet's elliptical orbit

Accordingly, Kepler started his hypothesizing anew, and after trying various other combinations of circles, he reached the point where he was ready to take a radical step. As previously noted, it had been before him a universally accepted assumption that the paths of all the heavenly bodies were circles or could be represented by some combination of circles, because the circle was the perfect form of curve and alone worthy of the perfect

[1] Quoted in Berry, *op. cit.*, p. 184.

creator and mover of the planets. And before Tycho had appeared with his precise data, the known facts were not so very repugnant to this conception, the possible margin of error being always large enough to include the deviations from a circular path. But Kepler's continued failure with all the combinations of circles that he could think of led him now to try the hypothesis that the orbit of Mars was an oval of some kind, discarding the hoary traditional prejudice. At first he tried an egg-shaped oval, but was soon forced to abandon this hypothesis. Then he tried the simplest known oval, the ellipse, and found to his delight that its deductions satisfied entirely the conditions of the observations, if the sun were taken to be at one focus of the ellipse. The eccentricity of the ellipse he determined to be about one-tenth. Accordingly, he was ready to formulate as verified the first of his famous three laws of planetary motion: *The planet describes an ellipse, the sun being in one focus.* And assuming, as he did provisionally, that the same law applies to the orbits of the other planets, it was possible on this new basis to eliminate most of the epicycles which Copernicus had been forced to retain, and to find encouragement for the belief that the remainder would also be quickly eliminated on more careful study of the remaining irregularities, freed now from the retarding ancient assumption.

**Of the law of the planet's motion**

Kepler then proceeded to attack the problem of formulating the law of variation of the velocity of the planet in different parts of its orbit. Observation showed that the planet moved faster when on the side of its orbit nearest the sun, and more slowly when distant from it. He tried various hypotheses to explain the law of this variation, and after many difficulties with the intricacies of their mathematical deductions, finally hit upon a simple law which was found to agree with observation. This he then expressed as the second law of motion: *The straight line joining the planet to the sun sweeps out equal areas in any two equal intervals of time.* Kepler's pleasure at this result may be imagined if we remember that it first solved in any satisfactory way the great puzzle of the irregularity of planetary velocities, the central point of attack in Copernicus's discussion

of Ptolemy's system, but too hard a puzzle for Copernicus adequately to solve. Kepler as well as Copernicus was firmly convinced, ultimately for religious reasons as we have seen, that some uniform law of motion must hold in astronomy, hence he was pleased indeed to find it possible to verify this principle as regards the areas, even though it had to be surrendered as regards the planet's path.

Of a functional relation between times of revolution and distances from the sun

The suggestion of his third law, that *the squares of the times of revolution of any two planets about the sun are proportional to the cubes of the mean distances of their orbits from the sun,* was hit upon almost accidentally in the course of a laborious attempt to develop further some early notions of his *Mystery of the Universe,* and to formulate in conventional notation the music produced by each of the planetary spheres. These speculations are published in a bulky volume named the *Harmony of the World,* appearing in 1619. How prone he was to extravagances of the traditional Pythagorean sort may be seen from a remark which he appends to the conclusion that the music emitted by the sphere of the earth is to be expressed by the third, the fourth, and the third notes of our major octave: "The earth sings the notes MI, FA, MI, so that you may guess from them that in this abode of ours MIsery (miseria) and FAmine (fames) prevail."[1] It was fortunate that in the midst of these labors it occurred to him that there might be some regular relation between the sizes of the planetary orbits and their times of revolution round the sun. The times of revolution had been known with accuracy since the early Greek astronomers, and by Kepler's day the distances had been pretty well determined in terms of the distance of the earth as a unit, though the actual distance of the latter from the sun in terms of its own diameter was still believed to be only one-twentieth of the true distance. Kepler himself, though on merely Pythagorean grounds, remedied this estimate somewhat. But, knowing these comparative values, Kepler tried a number of hypotheses of the mathematical relation between them, and soon was able to verify the simple law above stated. Replacing

[1] Berry, p. 191.

Kepler's somewhat inaccurate values by the modern figures, taking in the case of both distances and times that of the earth as unity, we may tabulate his law as follows:

| | Mercury | Venus | Earth | Mars | Jupiter | Saturn |
|---|---|---|---|---|---|---|
| Time of revolution....... | .24 | .615 | 1 | 1.88 | 11.86 | 29.46 |
| Square of time of revolution | .058 | .378 | 1 | 3.54 | 140.7 | 867.7 |
| Mean distance.......... | .387 | .723 | 1 | 1.52 | 5.2 | 9.54 |
| Cube of mean distance... | .058 | .378 | 1 | 3.54 | 140.8 | 867.9 |

The reason for the more noticeable divergence from the law in the case of Jupiter and Saturn was later indicated by Newton.

Speculations the of motion

One other historical point is deserving of mention before we leave Kepler. Up to this period, as we shall see more fully when approaching Galileo, astronomy had had no connection whatever with problems of terrestrial mechanics, save a very general metaphysical one which varied considerably among the traditional cosmologies. It had been believed by most that the source of planetary motion was the ever-present divine power, exerted directly from the empyrean on the primum mobile, and communicated by the latter first to the sphere of the fixed stars, and then to the revolutions of the various planets. But Copernicanism obviously made this set of ideas out of date. The fixed stars were now supposed to be immobile, and the sun was also believed to be unchanging so far as concerned its distance from them, though observations soon made it evident that the sun, like the earth, revolved on its own axis. And since, from the Copernican standpoint also, the other celestial bodies must be regarded as of essentially the same structure as the earth, the question became pressing: Whence the force which must be required to sweep such mighty bodies around in these elliptical orbits, and how is it applied to them? Kepler offered some speculations on this head which to a certain extent may be regarded as anticipating Newton. Since the sun was in a focus of each of the planetary orbits, and revolved on its own axis, it was natural that Kepler should turn to this revolution of the sun for the explanation required. Proceeding by analogy from the phenomena of magnetism, on which he had learned much

from Gilbert's epoch-making treatise on the subject appearing in 1600, Kepler offered the notion that the sun's magnetic attraction pervaded the space within which the planets moved, and carried as far as it reached a certain moving virtuc arising from the sun's own revolving motion. The planets thus share, to an extent varying with their distances, the sun's own motion of revolution, being swept around in the vortex of the sun's magnetic field. Pursuing the magnetic analogy further, Kepler suggested that the tides were due to some attraction of this sort between the moon and the water on the earth, but in the absence of sound mechanical foundations, he was unable to develop these ideas to the point where they could be susceptible of exact verification. Moreover, it must not be supposed that Kepler offered no compensations to the old theological foundation of the Aristotelian astronomy, which had lost pertinence to Copernicanism; he was too pious not to believe still that God was in some way the constant source of these celestial motions. Accordingly, reversing the spatial relations of the Aristotelian theology, Kepler conceived of the sun as the special habitation of God, and its magnetic virtue as a materialized expression of eternal divine power. In one passage, at least, he accommodates this scheme to the Christian doctrine of the Trinity, by mystically identifying the sun with God the Father, the sphere of the fixed stars with God the Son, while the eternal love between them, which is the magnetic virtue of the sun communicated to the planets to impel them on their courses, becomes the Holy Ghost.[1]

**Modern character of Galileo's thinking**

With such vagaries as these we shall not find it necessary to distress ourselves in Galileo, to whom we turn next. Indeed, were it not for such scattered instances before him as we find in Roger Bacon and Leonardo da Vinci, who likewise anticipated with remarkable sagacity the spirit and method of exact empirical science, but who cannot compare with Galileo in definite achievement, we should be much more astonished at the way in which he managed to extricate himself almost completely from traditional dogma and hampering metaphysics, and to guide

[1] *Opera,* I, 11.

his thinking along the lines which were destined to prove most fruitful and constructive.

Galileo was born in 1564 and died in 1642, his life thus overlapping that of Kepler, who had died in 1630, at both ends. We shall first mention the astronomical achievements which are of significance for our present summary, and then focus attention on his discovery of some of the fundamental laws of dynamics, for the latter are even more important in the general history of exact science, and in particular for the later discoveries of Newton.

Invention of the telescope

Early in 1609 Galileo learned of the invention by a Dutch spectacle-maker, a few months earlier, of a telescope, the fundamental principle of which had been anticipated by Roger Bacon and by at least two thinkers of the generation preceding Galileo. Realizing at once the tremendous value of such an instrument for astronomical observation, Galileo, without any detailed information of the structure of the spectacle-maker's invention, set to work to construct one for his own purposes. After a few trials he succeeded in arranging a convex and a concave lens in a tube in such a way as to enlarge by three times the apparent size of an object looked at. With further experimentation he was able to make telescopes which in the same way magnified thirtyfold. Though he was probably preceded slightly in his actual observation of astronomical data through such an instrument by the Englishman Harriot and the German Marius, his discoveries by its use became far more important than theirs. The results of his early observations were published in 1610 in a little book entitled the *Sidereal Messenger*.

The mountains on the moon

His first systematic observations were on the moon, which up to that time had been commonly believed to be perfectly smooth and spherical, indeed for most adherents of the older astronomy it was still supposed to be composed of more ethereal substance than the earth. Galileo at once recognized that many of the dark spots were shadows of lunar mountains cast by the sun, and that the bright spots near the boundary of the illuminated and dark portions were mountain-tops just catching the light of the rising or setting sun. From these observations he cal-

culated the height of some of the more prominent mountains, estimating the largest to be about four miles high. This result is not far distant from present estimates of the greatest height on the moon. Some of his other interpretations of observation were not so happy, but the primary importance of these discoveries was that they first offered empirical confirmation of the deduction from the Copernican view that the celestial bodies within our solar system, at least, are essentially like the earth. Hitherto this deduction had had to struggle with the hoary metaphysical and theological assumption that they were more perfect and different in substance than the earth, a belief which had seemed to be based firmly on empirical fact.

Illustration of Galileo's positivism

The extent to which Galileo was fully committed to the characteristic of scientific method which we have above described as positivism, that is, the insistence that traditional cosmological notions have no value whatever as soon as new empirical facts show that their underlying presuppositions were mistaken, is well revealed in his answer to a scientific critic of his doctrine about the moon. Ludovico delle Colombe in an essay *Against the Motion of the Earth,* tried to reconcile the old assumption with the new data by suggesting that the apparent valleys of the moon were really filled with some invisible crystalline material, so that the moon was, after all, perfectly spherical. Galileo answered this appeal to a hypothesis which was in the nature of the case entirely unverifiable by saying that the idea was so excellent it would be well to apply it further; accordingly, it was probable that the moon had on it mountains of this same invisible substance, at least ten times as high as any which he had observed! This positivistic emphasis he quite frankly expressed also against the authority of the Bible as a supposed source of truths about nature.

Methinks that in the discussion of natural problems, we ought not to begin at the authority of places of Scripture, but at sensible experiments and necessary demonstrations. . . . I conceive that, concerning natural effects, that which either sensible experience sets before our eyes, or necessary demonstrations do prove unto us, ought not, upon any account, to be called into question, much less condemned, upon the testimony of texts of Scrip-

ture, which may, under their words, couch senses seemingly contrary thereto. . . . Nor does God less admirably discover himself to us in Nature's actions, than in the Scripture's sacred dictions.[1]

Again, as regards the long-continued Pythagorean prejudice, from which Kepler had just broken away, that only perfect figures are appropriate in astronomy, he maintains that perfection in anything is wholly relative to the use to be made with it, implying that for science any figure is perfect if it represents the facts.

The phases of Venus

One of the deductions from the Copernican system (and indeed some of the ancient views as well) was that Mercury and Venus revolved round the sun at a distance from it less than that of the earth. If, moreover, they were dark bodies like the earth, they ought to pass through phases like those of the moon when on the earthward side of their orbits. It was well known that to the naked eye Venus varies very much in brilliancy, but the cause had not been known. Galileo accordingly made careful telescopic observations of Venus in October, 1610, which showed that she passed through phases similar to those of the moon. This confirmed further the Copernican deduction that the planets and the earth were essentially alike in their composition and structure.

Jupiter's moons—result for traditional ;

The most striking discovery announced in the *Sidereal Messenger* was that of four of the satellites of Jupiter. On January 7, 1610, Galileo happened to turn his telescope on Jupiter, and his attention was caught by three faint stars close to it and in nearly a straight line with it. He thought they must be fixed stars, but on looking again the next night saw that they had changed their positions relatively to Jupiter, but that the change was not such as could result from Jupiter's own motion. Continuing his observations two nights more, he was able to conclude definitely that the new bodies were not fixed stars, but were revolving around Jupiter. A fourth was noticed on January 13. Multiplying his observations again, night after night, by the time the book was published he had determined with fair accuracy their periods of revolution, which varied from

[1] Letter to the Grand Duchess Cristina.

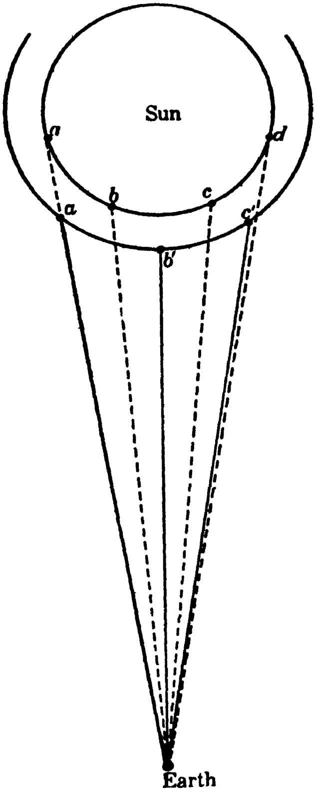
forty-two hours for the nearest to about seventeen days for the most distant.

Here again was a heavy blow to traditional ideas. In the first place it gave definite empirical confirmation to the new doctrine that the earth was not the only center of motion. In the second place, the moon ceased to be an anomaly in the Copernican system, as revolving round a moving planet, a motion which had so far been a real stumbling-block to the acceptance of the Copernican system. How could the moon, people asked, revolve round the moving earth without falling behind it in space?—a question impossible to answer in terms of the mechanical knowledge then available, and indeed it was still hard to see why even objects on the surface of the earth did not fly off in space, if the new theory of its motions were correct. The discovery of the satellites of Jupiter did not, of course, solve this difficulty, but at least it showed that the case of our moon was not unique. It furnished, therefore, no longer any excuse for rejecting the Copernican scheme.

A crucial experiment on the dark spots of the sun

A few months later Galileo began to study with his telescope the so-called dark spots on the sun. Other investigators also were examining them at the same time, but again Galileo's genius revealed itself in the way in which he considered possibilities that transcended their imagination and patiently subjected them to verification. It was noticed by all these observers that the spots appeared to move across the face of the sun from the eastern to the western side. On the strength of this fact some adopted the view that they were really small planets revolving round the sun, and appearing as dark objects whenever they passed between the sun and the observer. Galileo proceeded to develop the implications of this theory and then to test it carefully by further observations. These soon showed him that while a spot took about fourteen days to cross from one side of the sun to the other, through whatever part of the sun's disk it passed, its rate of motion was far from uniform, being much slower when near the sun's edge than when near its center. But neither of these facts was consistent with the proffered hypothesis, moreover, both of them suggested a different theory,

namely that the spots were on the sun's surface itself. Galileo then deduced the consequences of this theory as to the relative apparent rates of motion of a spot on a sphere when seen at




GALILEO'S METHOD OF DECIDING BETWEEN ALTERNATIVE HYPOTHESES OF THE SUN-SPOTS

Are the positions of the spot after equal intervals of time *a, b, c, d,* or are they *a′, b′, c′, d′*?

Angles *a′Eb′, b′Ec′,* etc., are approximately equal. But angle *bEc* is much larger than angle *aEb.* Observation verifies the latter.

a distance, and found them sufficiently verified by the data to conclude that they could certainly not be far from the sun's surface, if not actually on it. This seemed to establish another idea which was revolutionary to both the Ptolemaic and Coper-

nican views, the latter of which had held the sun to be perfect and pure in substance, and the former of which had also held it to be entirely unchangeable except for its motion round the earth. The fact that the moon always turns the same face toward the earth was of course the only empirical warrant for this belief. Galileo proceeded to fix the sun's axis and equator, and to determine the time of its rotation; on these points, however, his work was inferior to that of a contemporary, Christopher Scheiner.

By his use of the telescope in these ways, Galileo offered for the first time strong empirical confirmation of the Copernican astronomy—that is, a group of data which could not be accounted for at all by maintaining the earth as center of reference but which were one and all perfectly consistent with deductions from various aspects of the Copernican scheme. In his famous *Dialogues on the Two Systems of the World* he appeared in the rôle of the most vigorous literary and logical champion of the new astronomy that had yet stepped forth, a rôle for which he had to pay by penance and recantation at the hands of the Church, but these semipopular discussions need not be analyzed for our purpose.

The science of motion prior to Galileo

Let us turn now to his work in laying the foundations of the science of dynamics, which he describes in his *Dialogues and Mathematical Demonstrations Concerning Two New Sciences,* and some of the corollaries of which he applies to astronomical problems in the dialogues above mentioned. Here he wrote a still more important chapter in the history of exact science.

First we must recognize the prevailing form and extent of the science of local or terrestrial motion before Galileo revolutionized it. This was determined by the general principles governing all physical science during the Middle Ages, which we may describe in a brief phrase as qualitative and teleological rather than quantitative and experimental. To say that it was qualitative is to say that the importance of reaching exact numerical measures and relations of events had not yet been realized; the units appealed to were the characteristics of things as immediately revealed to sense observation, such as red, loud, sour,

heavy, hot, etc., and almost no attempt was made to discover underlying quantitative conditions of these sensed qualities. It was the great era of causal explanations not yet reduced to mathematical functions. Thus, for example, for this method of approach, steam, water, and ice were quite different substances, having hardly anything in common, because, of course, their evident sensed qualities are quite different, and nobody dreamed that they might depend on hidden conditions that differed merely in a numerical rate of motion. To say that this science was teleological is to say that the explanation of the relations of these qualitatively discriminated and defined events which seemed most satisfying was an explanation in terms of their purpose or use. In an age like ours, when many different purposes are taken for granted as legitimate, this would become a very difficult task, but in the Middle Ages men who wielded effective influence on the community were substantially agreed as to the main purpose of life and the world. This can, of course, be stated only in religious terms; it was the salvation of the souls of men for eternity, a salvation whose anticipatory foretaste was available even now in the form of the mystic vision of God, practiced directly by those who were expert in such matters and mediated to the masses as far as possible through the authority and ritual of the Church. Thus since "to know God and enjoy Him forever" was accepted as the supreme purpose of the entire drama of creation and history, the divine being became from the teleological standpoint the ultimate principle of explanation; all that happens in the inorganic and subhuman organic realms being construed in terms of its use for man's religious pilgrimage, and all that happens in human life being interpreted as having final significance in its bearing on the attainment of life everlasting in the presence of God.

Illustrated by examples

The outcome of this was that physical explanations were very different in character from those that have been built up by experimental study of the quantitative conditions of events in modern science. The fall of rain could be legitimately explained, for example, by pointing to its use in the nourishment of men's crops. And this teleological point of view, thus dominat-

ing the entire intellectual atmosphere, infected even the simplest statements of relationship between inorganic bodies themselves, where a good deal of encouragement to this mode of analysis was present in the continuing influence on thinking of primitive animistic modes of considering nature. The stone, when released from the hand above the surface of the earth, falls down, because being a form of earth-substance, it is out of its proper place when up in the air. Accordingly, when given an opportunity, it seeks its proper place and, having reached it, stays there until displaced by some external force. No interest was taken in getting a quantitative statement of the rate of motion of its fall. Galileo makes the remark that, although it had been known that falling bodies descend with accelerating velocity, "It is requisite to know according to what proportion such acceleration is made; a problem that I believe was never hitherto understood by any philosopher or mathematician, although philosophers, and particularly the peripatetics [followers of Aristotle], have writ great and entire volumes touching motion." [1] The same teleological principle was ultimately responsible for the assumption in astronomy which has already been noted, that the motions of the heavenly bodies must be such as can be represented by circles alone. For the circle is the perfect form of curve, and since these bodies are moved directly by the energy of a perfect being, to express his glory and symbolize for man the immutable realm of his perfection, it could hardly be possible that they should move in any other way.

Limitation and inadequacy of such a science

The bearing of all this on the analysis of problems concerning motion need hardly be discussed at length. So far as any distinctions were made about the nature of motion itself, they were qualitative rather than quantitative. Motions were distinguished according as they followed a straight line or a curve, the most familiar case of the latter being circular motion; they were also distinguished into natural motions, as the fall of a stone, and violent motions, illustrated by that of a hurled projectile. And the relation of any given motion to other events was expressed teleologically: the answer was an attempted answer to the ques-

[1] *Dialogues on the Two Great Systems* (Salusbury translation), p. 144.

tion *why* the motion took place, in terms of its purpose or use in the plan of the universe as a whole; not at all to the question *how* it took place, in terms of the quantitative structure of the motion itself.

What were the main inadequacies of such a science of motion, as tested by the science with which it has now been replaced? In the first place, the description of fact itself is meager and faulty. Something happens, of course, when a stone falls, which we may not inappropriately formulate as its seeking its proper place, but the statement is too meager to take into account the performances of the stone under unusual circumstances; when it is thrown up, for example, it does not begin to seek its proper place at once, but only after it has reached the top of its curve. Likewise, the explanation of rainfall as occurring to nourish man's crops does not adequately take account of the fact that the rain often falls where it can do crops no good and that sometimes it falls in such quantities as to destroy them. In the second place, these methods of statement are of value as expressing a limited range of explanatory interest merely. If you regard a religious interest of the contemplative, mystical type as being the only legitimate interest, doubtless this kind of science is the only kind that you would need; but if you are disposed to admit other interests as of justifiable value in human life, such as the interest of curiosity in the detailed understanding of how things happen, or the interest of practically controlling the processes of nature, it will hardly remain adequate. In the former case you will be satisfied merely to contemplate reverently the way in which all events point, in their purpose or significance, to the experience of divine absorption in which for you their value culminates, and this is just what the teleological method of analysis, as practiced in the mediæval period, did offer. In the latter case you will wish to expand such knowledge greatly in detail, make it consistent with recalcitrant fact, and relate all events to those quantitative, controllable conditions which will enable you to know exactly how to bring them about or prevent their occurrence. And this attempt will lead you sooner or later to govern your scientific investigation by just

those principles which we ventured to formulate in discussing Copernicus—the principles of empiricism, parsimony, and positivism, together with the equally inclusive principle of exact quantitative formulation of processes wherever possible. Some of the broader questions arising in this connection will be discussed in Part IV; at present we are concerned merely with the historical emergence of these interests which demanded a different type of physical science than that which religious contemplation had encouraged.

It is interesting to note that none of these early modern scientists with whom we are dealing was strongly influenced by visions of the possibilities of applied science in controlling the world of nature; that interest, while forcefully proclaimed by Galileo's contemporary, Francis Bacon, only very slowly came to affect the actual method of investigation and formulation in physics. The dominant interest of these pioneers was in the exact and detailed understanding of how things happened in the world, and while they were all profoundly religious men and therefore tended to carry over with them everything in the older theological assumptions about the universe which could be made to harmonize with the new facts uncovered by their work, they insisted on holding such assumptions flexibly, and allowing them no right whatever as against the quantitative laws and conditions which experiment revealed to obtain in the observed facts.

Galileo's dynamical assumptions

Now, though attempts to study certain forms of motion quantitatively did not make an absolute beginning with Galileo, yet previous investigators did not succeed in envisioning the type of problem which was sufficiently basic to yield a clue to the mathematical statement of the fundamental nature of motion. Characteristic of these earlier studies was the attempt at geometrical measurement of the cycloid, which is the path traced by a point on the circumference of a rolling wheel. And the attempt to formulate the orbits of the celestial bodies in previous astronomy is of course a case of the same sort. But the background for Galileo's problem was at hand when keen minds like Kepler and himself began seriously to think in terms of the Copernican astronomy. If the earth is moving as a whole according to

the same fundamental laws as the planets, laws that have been found susceptible of mathematical statement, the question is not far in the offing: Why should it not be possible to state mathematically the observed motions of small parts of the earth as we observe them on its surface? It is with this general background that Galileo begins his experiments, and it indicates a novel element in his attempt—he wants a quantitative formulation of the essential structure of motion itself, to reduce it to a descriptive functional law.

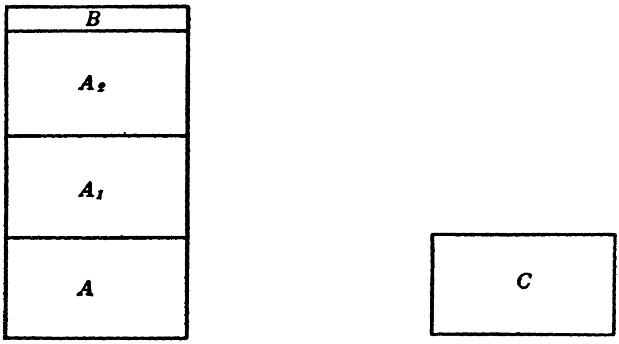
Observation of the swinging lamp

The first indication of the revolution which Galileo was preparing for the science of nature came when he was a lad of only eighteen years studying medicine at the University of Pisa. Happening one day, in the Cathedral of Pisa, to be watching the great lamp swinging as it hung from the roof, he noticed that as its motion died away the time occupied by each oscillation remained apparently the same. He immediately put this hypothesis to the test by counting his pulse, which was the only timepiece he had with him. The suggestion being verified, he proceeded to see whether the principle held for other swinging objects, and was soon able to formulate as verified a general law that any weight hung by a string swung to and fro in a time which depended only on the length of the string and certain characteristics of the weight itself, but not to any discoverable extent on the way it was set in motion, the breadth of its oscillation, or the duration of its swing. Accordingly, he devised a little instrument for measuring time by the oscillations of a pendulum, which was of course a great advance over the traditional hour-glass for such minute measurements as the rate of a patient's pulse.

Refutation of the Aristotelian theory of falling bodies

During the next seven years Galileo was occupied chiefly in building up his mathematical foundations, but when he took a professorship of mathematics at Pisa in 1589, he began a series of experiments, some of which were designed to test certain theories of motion which had been handed down unquestioned from the ancient philosophers, and some to verify novel hypotheses of his own. It had been believed, for example, on the authority of Aristotle, who had never tested the matter but had

simply deduced it from general principles, that a heavy body must fall faster than a lighter one, and in proportion to its weight. Before Galileo, apparently nobody had thought of performing the simple experiment which would have been necessary to test this assumption. The authority of tradition was all-powerful, and in any case the important thing was to save your soul in the world beyond, not to waste your time investigating religiously irrelevant happenings in this. But Galileo's keen mind saw that there was a contradiction in the reasoning by which the old belief had been supported. The heavier body




Galileo Discovers a Contradiction in the Traditional Theory of Falling Bodies.

A, $A_1$, $A_2$ are each equal to C.

falls faster because of its greater weight, had been the contention. But, saw Galileo, if we take two bodies differing in weight, it is possible to show on this reasoning that the heavier will fall more slowly than the lighter. For the heavier may be regarded as a compound of several bodies, some equal in weight to the lighter, one lighter still. Now, according to the accepted theory, parts A, $A_1$, $A_2$, etc., being equal in weight to C, will fall with the same velocity as C, and part B, being lighter than C, will fall more slowly. But since all these parts are attached together in one body, part B will retard the fall of the other parts, so that the entire body will fall with a velocity somewhat less than

that of C. In other words, the traditional theory contradicted itself. The only way of finding out the truth of the matter was accordingly to appeal from tradition to experiment. The famous leaning tower of Pisa furnished a splendid laboratory for the experiments by which Galileo soon showed that there was no truth in the ancient assumption at all. Dropping simultaneously weights of various sizes, he easily established that bodies of different weights fell nearly the same distance in the same time, the difference being not more than could reasonably be ascribed to the resistance of the air. In fact, it appeared likely that the only empirical ground for the ancient supposition was the fact that bodies of considerable bulk but lighter in weight are resisted so easily by the air, that they do, under normal conditions, fall more slowly than heavier ones.

**Galileo seeks a functional statement of their fall**

But the question of a functional statement became pressing. If all bodies, apart from the resistance of the air, fall at the same rate, just what is that rate, and how can we devise a technique for measuring it accurately? That the rate of fall was by a velocity that continually increased was already known, and was further evident from these experiments at the tower. But how to formulate this fact in exact terms—such was Galileo's question.

To answer this question by attempting measurements on freely falling bodies proved impossible; the fall was soon too fast, and it was before the day of anything remotely resembling a stop-watch. Accordingly, Galileo assumed that if balls were rolled down grooves on an inclined plane, the motion would be retarded sufficiently for exact measurement, while the form of the law would remain unmodified. But how to measure the time carefully was still a problem, for the only timepieces available were the traditional water-clocks and sand-glasses, which were very inaccurate and only of value for measuring great spaces of time. To meet this difficulty Galileo constructed a very simple water-clock, which he adjusted especially to the measurement of small spans of time. It consisted of a large vessel of water, having at the bottom a minute opening which could be closed with the finger. When the ball began to roll down the plane Galileo

removed his finger and allowed the water to flow out in a cup adjusted on the arm of a delicate balance. When it reached the end of the path he wished to measure, he closed the orifice. On account of the large diameter of the vessel, the pressure-height of the fluid did not perceptibly change, and therefore the weight of the water discharged from the opening was proportional to the time of its flow.

Use of instruments and of deductive elaboration

Galileo's first hypothesis, however, did not require the use of this instrument, for he was able to discover what appeared to be a self-contradiction in it before he subjected it to experimental testing. This hypothesis was that the velocity of a freely falling body increases directly with the distance traversed, so that, if its velocity is n feet per second after covering a given distance, it will be 2n feet per second after covering twice that distance. Not having yet established by experiment the precise relations between time and space as revealed in falling bodies, Galileo reasoned as though the body must have been traveling with its final velocity all the time. On this assumption the hypothesis is impossible, for if, after falling 2n feet, a body is going at the rate of 2n feet per second, we should have to say that it covers that distance in the same time that it took it to cover the first n feet, or in other words that it covered the second n feet in no time at all. But this, of course, could not be.[1]

The hypothesis of uniform acceleration

So Galileo then turned from space to time, hypothesizing that the acquired velocity is proportional to the time of the descent. This means that if a body fall through twice as long an interval of time as another, it will attain double the velocity of the other. This theory appeared to involve no self-contradiction, accordingly he deduced its consequences in the form necessary to guide experiment, and represented his theory in the rather cumbrous geometrical fashion that before the days of his mathematical successors was necessary. Since we mean by a velocity so many units of space traversed per unit of time, if we suppose that this velocity increases according to the time we must

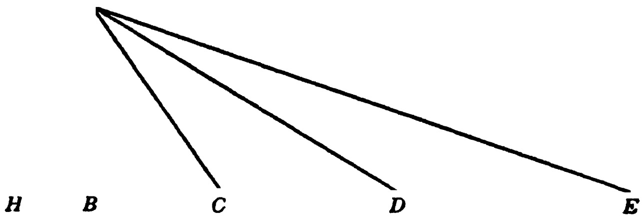
[1] The reader quite unfamiliar with mathematical physics may omit, through the balance of the chapter, the passages in which specific formulae are discussed.

suppose that the space traversed by a falling body increases according to the square of the time—the motion of fall is that of so many units of distance per second per second, or, more briefly, per second squared. Hence Galileo notched off on the groove of his plane distances equal to 1, 4, 9, 16 units, and noted that if his theory be correct these distances ought to be traversed in 1, 2, 3, 4 units of time. By the aid of his water-clock above described, he measured the time required for the ball to traverse each of these distances, and found the theory completely confirmed. The conception of simple acceleration, or of uniformly accelerated motion, by which we mean motion in which equal velocities constantly accrue in equal intervals of time, was thus for the first time made clear by Galileo's work, given quantitative formulation, and verified as the characteristic form of motion of a body falling down an inclined plane.

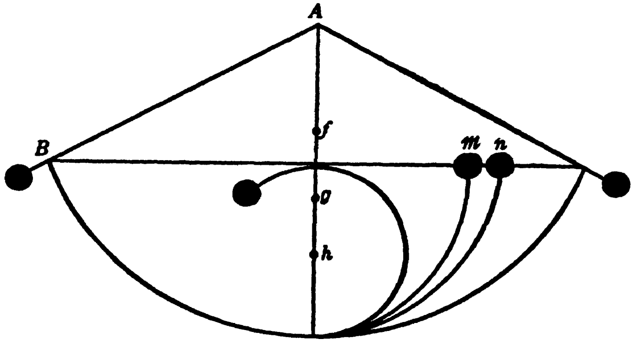
Confirmation of his earlier assumption

But Galileo continued his theorizing and varied his experiments, and the form in which his next speculations are put shows that he was still troubled somewhat about his assumption that the form of the law of descent is the same for a freely falling body as it is for a ball rolling down an inclined plane. Suppose a body is projected vertically into the air—what is the law of its motion? Obviously, the same acceleration toward the earth obtains in its case, and this acceleration will, in a time which depends on its original velocity, finally stop its upward motion and compel it to fall toward the earth again. While it is moving upward, in other words, it is being gradually retarded in accordance with the same law that it will obey when it has reached its topmost point and has begun to fall. Accordingly, if we conceive a falling body suddenly checked at any point of its fall, and projected upward with the velocity attained at that point, it will rise, apart from the resistance of the atmosphere, to exactly the level from which it descended. Now this means, Galileo saw, that the velocity of a ball at the bottom of an inclined plane, whatever the angle of inclination, is the same velocity that it would have if it had fallen vertically to the same level. For suppose that such velocity is less than it would have if it had reached the same level by a vertical fall. Then we could con-

struct a mechanism whereby a ball, having fallen vertically through a certain distance, should be started up an inclined plane at the velocity it has attained through its fall, and rise to a higher point than that from which it had originally descended. Suppose, again, that such velocity is greater than it would have if it had reached the same level by a vertical fall.




THE VELOCITY AT LEVEL H IS THE SAME WHETHER THE BODY FALL THROUGH AB, AC, AD, OR AE




GALILEO'S PENDULUM EXPERIMENT

Then we could accomplish the same result by another machine, rolling a ball down an inclined plane and then sending it vertically upward with the velocity it had attained at the bottom. In other words, in either case it would be possible, under appropriate circumstances, to force bodies continually upward solely by their own weight. This, however, wholly contradicts all our common-sense knowledge about the nature of heavy

bodies and the force of gravity. It seems clear, therefore, that the same law of descent applies whatever be the angle through which a body falls, and that the velocity reached at any given level parallel to the earth's surface is the same whatever the angle of descent.

Verification by the pendulum experiment

Not content, however, with reasoning this out from general principles, Galileo constructed an experiment to verify it. He made a pendulum by the simple expedient of tying a heavy ball to a thread and fastening the end of the latter to a nail. Holding the pendulum up on one side at a given altitude above its position when it hung freely, he let it fall, and noted that it ascended to the same level on the opposite side. If it does not do so exactly, he maintained, the resistance of the air must be the cause of the deficit, because we see that the deficiency is much greater in the case of lighter balls of the same bulk. Now we can regard the motion of a pendulum in its descending arc as a motion of descent along a series of inclined planes of different inclinations. Likewise its rise on the opposite side can be viewed as an ascent on a different series of inclined planes. In order to show that, whatever the angle of ascent or descent, the body can rise only to the same height from which it descended, we drive a nail in at one side of the thread as it hangs freely, at f or g. Holding the pendulum at B again, we let it fall. When the thread arrives at the vertical line and strikes the nail, the ball will ascend through a different curve or by a different series of inclined planes, but it rises none the less to exactly the same level, at n or m. And if we drive the nail so low down, as at h, that the remainder of the string cannot reach to that level, the ball will turn completely over and wind the thread round the nail, since when it has attained the greatest height that the nail permits it still has some velocity left.

Galileo proceeded to determine the law governing the space covered in any given time by a ball rolling down an inclined plane, and found it is always equal to the chord subtended by the angle of inclination of the plane in the circle whose diameter was traversed by the ball when falling freely. From this he

deduced a number of interesting theorems, some of which are still presented in our elementary text-books of mechanics.

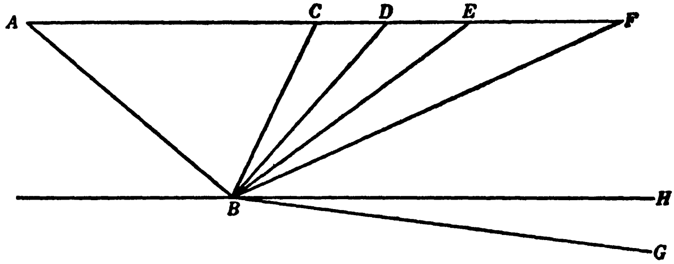
Emergence of the concept of inertia

Of more importance for our further consideration of Galileo's work, however, is the set of revolutionary conceptions and assumptions about the nature of motion to which he was led by these experiments. Fundamental here is the novel conception of *inertia,* which later became expressed in its classic form by Newton as the first axiom or law of motion. Prior to Galileo, motion had been regarded as less natural to a body than rest; when external forces set it in motion, it tended, as soon as possible, to find its proper place in which it could rest. The empirical facts on which this conception was founded are sufficiently obvious; due to the various resistances which bodies interpose to one another's movements, no concrete motion that we are familiar with is perpetual. Accordingly, from the pre-Galilean standpoint, even to maintain a body in motion with constant velocity requires the exercise of force, which failing, the body must soon come to rest. Circular motion being the natural motion for the stars and planets, the continual exercise of divine energy was therefore needed to keep them going round, a dynamic doctrine which Kepler did not transform in principle when he postulated the sweep of the sun's magnetic field as the constant cause of the planetary revolutions. But Galileo's revolutionary experiments implied the discovery that it was just as easy, so to speak, for a body to move with constant velocity as to remain at rest. It is positive or negative accelerations that the application of force brings about, not uniform velocities.

Demonstration of its reality

The most interesting way in which Galileo was brought to this assumption may be stated in connection with his experiments on the inclined planes. Suppose we conceive a body falling down an inclined plane AB, from the level AF to the level BH. The considerations already explained, together with the experiments on the pendulum, showed that with the velocity acquired by the body at B, and neglecting the resistance of the atmosphere, etc., the body would be able to ascend to the level AF again by a plane of any angle connecting B with that level, such as BC, BD, BE, or BF. The retardation or negative acceleration on BC

would of course be greater than on BF, but this is compensated for by the shorter distance, so that in the case of all these planes the body would be able to rise exactly to the level AF again. The exact quantity of retardation will be present that will be required in each case to bring the body to rest when it reaches the level AF. Now consider what will happen if, instead of ascending one of these planes, the body continues downward at B, though on a less precipitous slope than AB, such as BG. Clearly its positive acceleration will continue, though the rate of acceleration will be smaller than before. Where lies the limit between retardation and acceleration? Obviously this is set by




the level BH, parallel to AF. And what will be the behavior of the body if it continue its motion on this level? It will be neither retarded nor accelerated, which means that it will continue to move with the velocity reached at B, as long as some other force does not interfere. Apart from that, its motion could not cease, nor could the velocity change. Conditions make it impossible for us to verify this by experiment, but many experiments verify it indirectly. We can show, for example, that the more we eliminate friction and the resistance of the air, the more nearly does motion on a horizontal plane approximate the norm expressed by the law.

Historical significance of the first law of motion

Thus the traditional conception of motion as requiring the exercise of force for its maintenance is replaced by the conception of uniform velocity rather than rest as the normal condition of bodies—a fundamentally static view of the world of nature is abandoned implicitly in favor of a dynamic view, by which

is meant the assumption that the normal object of physical study is a process of change or motion rather than a static group of qualities united by definition in a substantial form. Galileo does not formulate this law in the clearly generalized axiom of Newton, but it is evident that he fully recognizes its nature. His statement is: *Conceive a body projected or thrown along a horizontal plane, all impediments being removed. Now it is clear by what we have said before at length that its motion will be uniform and perpetual along the said plane, if the plane extend indefinitely.* In terms of this conception, then, all forces are circumstances determinative of accelerations, not of simple velocities, and Galileo shows in various ways that he is equally cognizant of the further aspect of the law as stated by Newton, that anything which deflects a body from motion at uniform velocity in a straight line, must be exercising force upon it in this sense.

**Inertia of a projectile**

Galileo likewise made some progress in the investigation of more complex motions. Consider, for example, the case of a projectile hurled horizontally from the mouth of a cannon. Apart from the resistance of the atmosphere, this projectile will be moving simultaneously in two ways. On the one hand there is its own inertia, which, if acting alone, would carry the ball in a straight line at a constant velocity. On the other hand, there is the force of gravity, which is carrying it toward the earth at a uniform acceleration. Galileo perceived that these motions are essentially independent of one another, and in dealing with their combination he therefore used implicitly the principle of the parallelogram of forces later worked out explicitly by Newton. The actual motion of the projectile will, accordingly, form an oblique curve compounded of a uniform horizontal velocity and a uniform acceleration toward the earth. By holding fast to the essential principles thus revealed, and by making use of the methods of higher branches of mathematics, problems of oblique projection and of projection under the influence of other forces were readily subjected to solution. This conception of the essential independence of circumstances

determinative of motion was given formal expression by Newton in his second axiom of motion.

Galileo points out matters of common-sense observation which illustrate the basic law of inertia, and which had not been adequately explained in terms of the traditional assumptions about motion. There is the case of the rider thrown over the head of his horse by the latter's sudden stop, and that of the bodies in the cabin of a moving ship, which have no tendency to lose the motion imparted to them by the ship, but, when they fall, fall to all appearances exactly as if the cabin were at rest. This shows, he pointed out, that while falling, these bodies retain the forward motion of the ship and combine it as an independent factor with the motion imparted by gravity.

Application of these principles to planetary theory

What became the bearing of these discoveries on astronomical problems? Well, some of the implications of these laws helped greatly, even in Galileo's first development of them, in answering certain objections to the Copernican astronomy which had so far been rather difficult to answer satisfactorily; some, on the other hand, led to the posing of new problems about the celestial motions which were not answered till Newton united terrestrial dynamics and astronomy in a single comprehensive science of matter in motion. Let us consider these consequences successively. Under the first head the behavior of objects near the surface of the earth no longer interposed difficulty to the view that the earth was in rapid motion. Why does not a stone dropped from the top of a tower, for example, fall considerably to the west in its descent, if the earth's surface is moving rapidly toward the east? And why are not the clouds, the atmosphere, birds flying in it, and loose objects lying on the earth's surface, left rapidly behind in a westerly direction as the earth moves? In terms of Galileo's new principles these facts were easily accounted for. Such objects shared the rotational velocity of the earth's surface, and it would require some additional force to make them fall behind, not to make them behave as they do. The phenomena familiar to everybody were thus

shown to be as consistent with the doctrine of the earth's motion as with the doctrine that it remained at rest.

Under the second head, the problem obviously took an entirely new form now as to the actual forces that could account for the motions of the planets. The old idea that their natural motion was circular or, as Kepler had shown, elliptical, no longer satisfied. If the general principles of dynamics applied to them, their motion, however originally started, ought to continue at uniform velocity in a straight line, not in an ellipse. What force held them in an elliptical orbit? It was not long, of course, before thinkers began to speculate in this connection with Kepler's notion of a magnetic attraction emanating from the sun, not now to sweep the planets around as a result of the sun's rotation as he supposed, but to hold them in an orbit instead of permitting them to fly off at a tangent. But it required further investigation along several lines before it was possible to state this problem in a form susceptible of precise verification.

Order of Galileo's scientific procedure

Before leaving Galileo, let us sum up the main characteristics of his scientific method, in order to reveal aspects of scientific discovery which were noted in general in the last chapter of Part I, and discussed more explicitly in the earlier chapters of the present part. Under the urge of curiosity to understand the world, and making the general assumption that nature is at bottom a system of mathematical law, Galileo proposes to study the essential character of motion. He picks out a case of motion that seems on the basis of frequent experience to be fundamental and typical. Examining such a typical case, he sets up a hypothesis as to the mathematical law revealed in it. He deduces the consequences of this hypothesis in such a form as is necessary to guide verifying experiments. Then he makes the experiments, constructing measuring instruments where none are available. If the law is verified, he deduces further consequences as to what ought to be true in more complicated cases, and tests them likewise; if at any stage of the procedure the verification does not appear, further hypotheses are sought in the light of what the experiments have revealed, and are

then subjected to testing. Thus a system of laws is gradually built up, and before long the basic assumptions implied in them all are disentangled and explicitly formulated as the axioms of the science. In these fundamental steps, Galileo is but setting the standard for the subsequent procedure of all exact science. The essential positivism of this method is worth particular note. The only metaphysical dogma present in his procedure is the basic assumption of all exact science, namely that nature partakes of an orderly mathematical structure, which it is possible to bring to light as the underlying condition of its puzzling surface events. On all other matters that transcend scientific verification Galileo tends toward a definitely agnostic position (with reservations on the side of his final religious beliefs)—it does not trouble him to leave such things in an unsettled state while he expands exact knowledge where it seems possible to do so, laying sound foundations for a possible future solution of these larger problems.

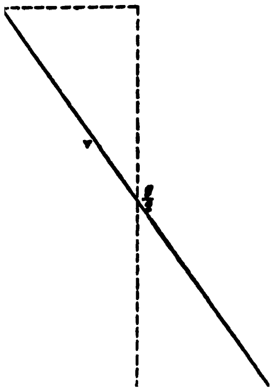
Huygens invents the pendulum clock

Before we come to Newton we must consider briefly Christian Huygens, who was born in 1629, died in 1695, and who published the most important results of his investigations in his work on the pendulum clock (*Horologium Oscillatorium*) which appeared in 1673. As the title suggests, Huygens became the inventor of the first clock so constructed that its machinery kept the pendulum moving and the pendulum in turn by the regularity of its oscillations regulated the motion of the clock. When Galileo had discovered the law that the time of oscillation of a pendulum remains constant, he had made use of a simple pendulum for measuring time, but he had no machinery to keep the pendulum in motion, hence the instrument was valuable for rather brief times only. Huygens' instrument was the first to remedy this difficulty and offer a dependable timepiece to replace for all important purposes the old water-clocks and sand-glasses of the ancients. The clock could be adjusted to keep correct time by regulating the distance of the pendulum bob from the center of oscillation. Thus appeared the first fruit of the new dynamical discoveries in the form of an invention that quickly passed into the everyday use of

the average man, showing the value of the new knowledge for meeting practical needs of ordinary human living.

Deductive development of Galileo's laws

But the significance of Huygens for the main sequence of thought which we are now pursuing lies in his deductive development of Galileo's laws of acceleration in such a way as to show their application to certain problems about the motion of the planets and their satellites. To bring out this development we must return to the form in which Galileo had expressed the



HUYGENS' DEMONSTRATION THAT $s = \frac{g}{2}$. AS THE VELOCITY INCREASES UNIFORMLY FROM 0 TO g, THE DISTANCE COVERED IS EQUAL TO THAT TRAVERSED BY A CONSTANT VELOCITY OF $\frac{g}{2}$

relations between time, space, velocity, and uniform acceleration. In the behavior of a body moving with such an acceleration, let g be its acceleration in feet per second per second, v its velocity in feet per second at the end of a given time, t the time, and s the space traversed during the time. First we determine the relation between s and g and t. Let a body start from rest with a motion of uniform acceleration. In a unit of time it will have gained a unit of acceleration g, for this is what uniform acceleration means; it is increase of velocity in proportion to the time. Therefore at the end of this unit of time its velocity is g, since it started with no velocity. Now what dis-

tance has it covered in this unit of time? The answer is, $\frac{g}{2}$. For since the increase of velocity has been uniform, beginning at o and ending at g, the body covers the same distance as it would have covered if it had been moving the entire time at a constant velocity equal to that which it possessed at the middle of this unit of time. Now this velocity is obviously equal to half that which it possesses at the end of t. Since the latter is equal to g, the velocity at the middle of t is equal to $\frac{g}{2}$, and therefore the distance covered in t is equal to $\frac{g}{2}$. We may express the matter in this way. In a motion of uniform acceleration, whatever loss is suffered in the first half of the motion as compared with uniform motion at half the final velocity, is made up in the second half, as the accompanying diagram shows. But now what will be the distance covered in a number of these units of time? Here we note that the conception of uniform acceleration means that $v = gt$, for since the acceleration is proportional to the time, the velocity at the end of three units of time will be equal to three times the acceleration gained in every unit of time. But we see above that s is always equal to $\frac{v}{2}$ in cases of uniform acceleration. Accordingly, s after any given number of units of time is equal to $\frac{tv}{2}$, which in turn $= t\left(\frac{gt}{2}\right)$. Our fundamental relations, therefore, may be expressed as follows:

$$v = gt \qquad s = \frac{gt^2}{2}$$

Huygens later found it desirable to state s in terms of v and g, and in so doing laid the foundation for further important dynamical conceptions, but we need not consider this formula.

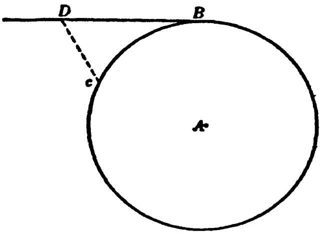
Now Huygens proceeded to apply such formulæ to cases of uniform circular motion. He noted that in terms of the axioms

Application of the deduction to circular motion

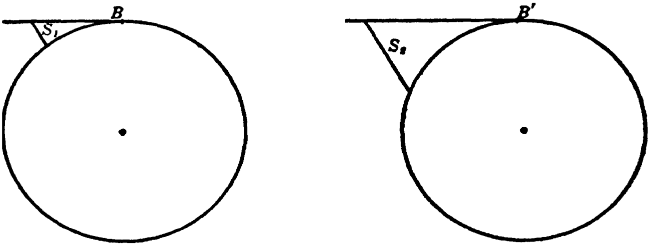
that Galileo's work showed to be fundamental about motion, a body moving uniformly in a circle must be deflected from its rectilinear path by some constant force that pulls it toward the center of the circle. Otherwise it would move off at a tangent to the circle. The tension of a string when a stone is whirled round in a circle is an illustration of such a centripetal force. Accordingly, such a body must be moving with constant acceleration toward the center of the circle, as well as with a constant velocity in a straight line; its observed motion is a compound of these two motions. What is the acceleration revealed in such uniform circular motion, and what relations does it have to the velocity of circular motion and to the radius of the circle? Such were Huygens's questions; their significance for astronomy is evident.

From Galileo's laws the answers were not difficult. Suppose a body B moving in a uniform circular motion around point A. Were it not for the centripetal force it would, after an interval of time t, reach position D, on the tangent to the circle at B, whereas it is actually at that time at position C in its circular orbit. Accordingly, its uniform acceleration toward A is equal to that which would bring it over the distance DC in time t. Now from Galileo's law that $s = \frac{gt^2}{2}$ we can state g in terms of s and t. Multiplying by 2 and dividing by $t^2$, we find that $g = \frac{2s}{t^2}$, and if t be our chosen unit of time it will be equal simply to 2s, which in the case of uniform circular motion equals 2DC. If the second be our unit of time, then, the acceleration in such a motion is equal to 2DC per second squared. But obviously the quantity DC depends on the velocity of the body in its orbit. What law does the acceleration obey in relation to the velocity? Let us consider two bodies revolving in circles whose radii are the same, but the velocity of the one being double that of the other. Let $g_1 =$ the acceleration of the slower body, $g_2$ the acceleration of the faster. Now $g_1 = \frac{2s_1}{t_1}$, and $g_2 = \frac{2s_2}{t_2}$. But if s be taken as equal in these two cases, $t^{1}_{1} = \frac{1}{2}t^{2}_{2}$. Substituting and solving,

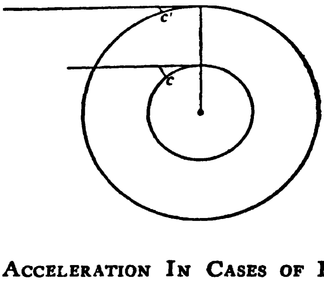
we reach the result that $g_2 = 4g_1$. But $4 = 2^2$, and by testing with other units we reach by generalization the rule that *in equal circles the centripetal acceleration is proportional to the square*




ACCELERATION IN CASES OF UNIFORM CIRCULAR MOTION




COMPARATIVE ACCELERATION IN CIRCLES OF EQUAL RADIUS




COMPARATIVE ACCELERATION IN CASES OF EQUAL VELOCITY

*of the velocity of the circular motion.* Now let us consider what will be the law when the radii are different but the velocity of circular motion the same. Given two circles, the radius of the second being twice that of the first, and bodies revolving

in them with equal velocity of circular motion, so that the same arc is swept over in the same interval of time. Then if $g_1$ and $g_2$ denote the respective accelerations, s and 2s will denote the respective distances covered in virtue of the accelerations. Since the circular velocity is the same, t is the same for both cases. Now $g_1 = \frac{2s}{t}$, and $g_2 = \frac{2.2s}{t} = \frac{4s}{t}$. That is to say, $g_2 = \ g_1$. If now we reduce the velocity in the second case by one-half so that the actual velocities in terms of distance covered will become equal in the two cases, our previous theorem shows that $g_2$ will be reduced one-fourth, so that it will be equal to $\frac{1}{2}g_1$. Generalizing, we come to this rule: *When the velocity of uniform circular motion is the same, the centripetal acceleration is proportional inversely to the radius of the circle described.* That is, if the radius is twice as great, the acceleration is one-half as great; if it is three times as great, the acceleration is one-third as great, and so on. Combining these two laws in one, then, we may say that *a body moving in uniform velocity in a circle reveals an acceleration that is directly proportional to the square of the velocity and inversely proportional to the circle's radius.* In symbols, $g = \frac{v^2}{r}$.

**Relation of these results to Kepler's laws**

The significance of this for dealing with certain astronomical problems arising in connection with Kepler's laws will be seen when we express Huygens's result in a somewhat different form. If we denote by t the periodic time of the circular motion—that is the time occupied in describing the entire circumference—then the velocity will be expressed as equal to that circumference divided by such periodic time of revolution, since the velocity always equals the distance covered in the unit of time selected. But the circumference of a circle $= 2r\pi$. Therefore the velocity $= \frac{2r\pi}{tr}$. Substituting this value for v in the above equation, we have $g = \frac{(2r\pi)^2}{tr} = \frac{4r\pi_2}{t}$. This means that if several bodies moving in circular orbits have the same periodic times,

the respective centripetal accelerations by which they are held in their paths are proportional to the radii of their orbits.

Such results enabled Huygens to explain clearly various phenomena which had hitherto lacked adequate explanation. If the earth is rotating about an axis passing through the poles, as the new astronomy believed, then the earth's surface at the equator is moving with much greater velocity than its surface nearer the poles; its centrifugal force is therefore greater at the equator, and if the force by which it is held toward the center is the same, the earth will tend to bulge at the equator, and the behavior of bodies under the influence of gravity will be somewhat different at the equator from their behavior nearer the poles, due to this greater centrifugal tendency. When, for example, John Richer took a pendulum-clock from Paris to Cayenne, which is only five degrees north of the equator, and found a retardation of its oscillatory motion, Huygens was able to account for the smaller intensity of gravitative acceleration thus shown in terms of this equatorial bulging of the earth.

**Form now taken by the problem of planetary motion**

Huygens's researches indicate that the great problem stirring speculative imagination now as a result of the laws of celestial motion formulated by Kepler and the laws of terrestrial dynamics established by Galileo, was to see if these could not be brought together in a single comprehensive system and shown to follow from some still more inclusive law that would unify and explain all of them. But it is evident that thinkers were feeling their way into this problem only very slowly as far as its clear formulation is concerned; moreover, better answers to certain preliminary questions were needed before a precise answer to such a problem could be expected.

**Determination of the size of the earth**

One of these problems was to determine accurately the size of the earth. If, noting that the acceleration due to gravity differs at the equator from the acceleration farther north, and explaining this difference by Huygens's laws of the mutual relations of circular velocity, acceleration, and distance from the center of revolution, we allow ourselves to hypothesize that the earth's gravitative attraction reaches as far as the moon, or that of the sun as far as the planets, we must know the radius of

the earth and the distance of the moon and the planets in order to compare the acceleration at the earth's surface with the acceleration at the distance of the moon. Fortunately, the vastly more accurate instruments of observation now available, allowing minute differences in the positions and angles of the celestial bodies to be noted when synchronous observations were taken at different points on the earth's surface, made possible a much more exact measurement of the length of a degree of the earth's circumference, $\frac{1}{360}$ of a great circle.

Willebrord Snell, a contemporary of Galileo, had made a series of measurements in Holland in 1617, which resulted in an estimate of the length of a degree of about sixty-seven miles; one of his pupils corrected some errors in his calculations and altered the estimate to about sixty-nine miles, which was within a few hundred feet of the value now accepted. In 1636 Richard Norwood made observations at London and York and measured the distance between the two cities, resulting in an estimate of the length of the degree with an error of less than half a mile. Finally Jean Picard, a contemporary of Huygens, made measurements near Paris in 1671 which yielded a result only a few yards in error. Knowing the length of a degree with reasonable exactitude, of course the circumference and radius of the earth can at once be deduced. The importance of these investigations may be seen from the fact that earlier attempts to measure the length of a degree were apt to err as much as fifteen per cent of the true value.

Independent discoveries of the law of the inverse square

It will be observed that the last mentioned of Huygens's formulæ may be expressed in terms of the attraction exerted by a central body on a satellite revolving round it in a circular orbit, if we assume that this attraction is the force deflecting the satellite from a tangential motion. The attraction will vary inversely as the square of the distance. During the decade of the 'seventies several men were working more or less independently on the problem stated in this form.

Robert Hooke was one of these; he suggested that this attraction varied inversely with the square of the distance of the

object on which it was exerted, and intimated that the motions of the planets might be accounted for by such an attraction between them and the sun. The famous architect Christopher Wren also discussed questions of this sort with Newton later in the 'seventies, and a few years later Edmund Halley discovered the law of the inverse square as a deduction from Kepler's third law of planetary motion. He raised with Wren and Hooke the more general problem as to what curve a body would move in if acted upon by an attraction which varied according to this law, but none of the three could devise a solution of the problem.

It is at this point that the genius of Newton came upon the scene. In him were concentrated all the scientific virtues that we have noted in his great predecessors, and he also possessed a boldness of speculative imagination and a clarity of mathematical analysis in which he probably surpassed them all. Born in 1642, he published the famous *Mathematical Principles of Natural Philosophy,* in which the laws of motion and the principle of universal gravitation are mathematically formulated, in 1687. **Newton's genius**

As with many great geniuses, the clue which was destined to prove fruitful in all his important lines of achievement came to Newton fairly early in life and was developed at once to the point where the problems that remained to be solved before the fundamental perplexity could be adequately answered, revealed themselves clearly, and in time for his powerful mind to concentrate upon them while still in the vigor of youth. Besides his remarkable achievements in mechanics and astronomy, with which alone we shall be occupied, he was one of the two greatest pioneers of his age in optics and in mathematics, and it is significant that in all three of these subjects the leading ideas of his later demonstrations occurred to him within two years after he took his college degree—that is, by about 1666, when he was only twenty-four years old. His own picture of this precocious mental activity in the field of constructive imagination, written long afterward, is summed up in the following paragraph:

In the beginning of the year 1665 I found the method of approximating Series and the Rule for reducing the dignity of any Binomial into such a series. The same year in May I found the method of tangents of Gregory and Slusius, and in November had the direct method of Fluxions [Newton's form of the infinitesimal calculus], and the next year in January had the Theory of Colours, and in May following I had entrance into the inverse method of Fluxions. And the same year I began to think of gravity extending to the orb of the Moon, and having found out how to estimate the force with which [a] globe revolving within a sphere presses the surface of the sphere, from Kepler's Rule of the periodical times of the Planets being in a sesquialterate proportion of their distances from the centers of their orbs, I deduced that the forces which keep the Planets in their orbs must [be] reciprocally as the squares of their distances from the centers about which they revolve; and thereby compared the force requisite to keep the Moon in her orb with the force of gravity at the surface of the earth, and found them answer pretty nearly. All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention, and minded Mathematicks and Philosophy more than at any time since.[1]

Early formulation of his problem

With reference to the line of thought with which we are concerned it is interesting to note that at this early age Newton has anticipated the speculations of Hooke, Wren, and Halley, and applied them concretely to the orbit of the moon, and has also anticipated some of Huygens's deductions. There is probably some historical justification for the well-known story that it was the fall of an apple in the orchard that first set him directly meditating on the problem how far the gravitative force of the earth reached. As the above investigations show, since the implications of Galileo's work had penetrated the minds of thinkers, it had been more and more realized that the real problem about the orbits of the planets and of their satellites was not to explain how they were pushed along in their paths—that was accounted for by the fundamental principle of inertia—but how to account for the acceleration which holds them in their orbits, without which they would fly off at a tangent. Now the force which produces this acceleration acts in the direction of the center of the orbit, which is very near the location of the sun in the case of the planets, the center of the earth in the

[1] Quoted in Berry, p. 212f.

case of the moon. There is a constant influence tending to draw the body in motion toward that center, sufficient to counteract the tendency which it has, in virtue of the first law of motion, to get farther and farther away from that center along a tangential course. In other words, to explain such circular motion, and explain it completely in terms of the new foundation assumptions of dynamics, we need to show that the body has, in addition to its original velocity, however secured, an acceleration of a certain definite magnitude directed toward the center of the circle. Viewed as a purely general question in the theory of dynamics, apart from any astronomical application, the problem is simply: Under what conditions can a body revolve with uniform velocity in a circle? This was in essence the problem with which Huygens was occupied in the investigations recounted above. As a result of his work a definite quantitative measure was secured for the tendency of a body moving in a circle to recede from its center, a tendency which is exactly counteracted by the force holding the body equidistant from the center. He further discovered, as we saw, that this acceleration of the body toward the center of its orbit varied according to the square of the velocity and inversely to the radius of the orbit. We may exemplify this by a simple case: Suppose we have a body moving in a circle whose radius is five feet, at a velocity of fifteen feet per second. Then the acceleration of such a body toward the center of the circle is equal to $v^2/r$, or $\frac{15.15}{5} = 45$ feet per second per second. The general truth revealed in exact numerical form in these laws is familiar to anyone who has whirled a sling round his hand at varying velocities and with varying lengths of the cord. The faster the velocity, the greater the force with which the sling pulls at the hand; while the longer the cord, the smaller that force becomes if the sling is moving at about the same speed.

**Is the moon a falling body?**

Now in just what form did the problem take shape for Newton in these early attempts to deal with it? Here were the planets revolving in orbits which were not very different from circles, and not far from the center of these orbits was the sun;

in a similar manner the moon was revolving round the earth as a central body. If we suppose that the acceleration toward the center which these motions reveal is caused by some influence emanating from the central body, it becomes natural to suppose also that this influence may be identical with the gravitative force shown on its surface. It was evident that the gravitative power of the earth extended upward to the boughs of the apple trees, to the tops of mountains, and as high as projectiles could be hurled from a mountain-top—does it extend as far as the moon? And is it perhaps just the force which gives the moon the centripetal acceleration needed to maintain it in its circular orbit? Such was the daring hypothesis first conceived clearly by Newton's speculative imagination.

Discovery of a functional relation between Galileo's and Kepler's laws

To test this bold idea it was first necessary to find an answer to the question later answered independently by such men as Huygens, Hooke, and Halley. In what relation does the centripetal acceleration stand to the distance of the moving body from its center? To reach an answer to this question Newton made use of Kepler's third law together with the principles of dynamics involved in Huygens's deductions. According to Kepler's law, the squares of the times of revolution of any two planets are proportional to the cubes of their mean distances from the sun. Now the velocity of any planet may be found by dividing the length of its path around the sun by the time of its revolution, and that path is proportional to the distance of the planet from the sun, being its product by $2\pi$, the relation holding between the circumference of any circle and its radius. Hence the velocities of the two planets are proportional to their distances from the sun, divided by the times of revolution; consequently, the squares of the velocities are proportional to the squares of the distances from the sun divided by the squares of the times of revolution. Kepler's law is thus seen to involve the conclusion, reached by substitution of equals, that the squares of the velocities are proportional to the squares of the distances divided by the cubes of the distances, or, that the squares of the velocities are inversely proportional to the distances, the nearer planet

having the greater velocity, and *vice versa.* This deduction may be represented symbolically as follows:
By Kepler's law:

$$T^2 \propto D^3$$

But $$V = \frac{S}{T} = \frac{2\pi D}{T}.$$

That is, $$V \propto \frac{D}{T}, \ V^2 \text{ with } \frac{D^2}{T^2}, \text{ which} = \frac{D^2}{D^3}, \text{ which} = \frac{1}{D}.$$

But the principle used by Huygens showed that the acceleration of a body in circular motion is proportional to the square of the velocity divided by the radius of the circle, which in these cases is the distance of the planet from the sun. Accordingly, substituting in the above, the accelerations of the two planets toward the sun are inversely proportional to the squares of the distances.

$$G \propto \frac{V^2}{D}, \text{ with } \frac{D^2}{D \cdot D^3}, \text{ or } \frac{1}{D^2}.$$

Newton thus reaches the result that the motions of the planets, disregarding irregularities, can be explained as due to the gravitative attraction of the sun if that attraction can be shown capable of producing on the planet an acceleration toward the sun which is inversely proportional to the square of its distance from the sun. This means that at twice a given distance the acceleration would be one-fourth as great, at three times one-ninth as great, at five times one-twentyfifth as great, and so on.

The application of this to astronomical problems becomes clear when we take the attraction of the sun on the earth and Jupiter as an illustration. In round numbers the distance of Jupiter from the sun is five times the distance of the earth. Now since the sun's gravitative force varies inversely according to the square of the distance (if it is this force that keeps the planets in their orbits), its attraction on Jupiter, and consequently the latter's acceleration toward it, will be $\frac{1}{5 \cdot 5}$ that of the earth. This law of the inverse square, as it is called, is of great scientific interest for many reasons which are beyond the scope of the present summary. It can be shown geometrically

to be the law which must express the progressive diminution, with increasing distance, of any effect whatsoever emanating from a central body equally in all directions.

Now how was Newton to test this grand hypothesis that should unite dynamics and astronomy under a single system of law? Nobody knew what the acceleration of gravity was on the sun's surface, and the conception of mass, which would have been necessary to apply the idea in default of such knowledge, was yet to be given mathematical clarity. But here, fortunately, was the moon, whose revolution round the earth presumably exemplified the same laws as were revealed in the planetary motions. The acceleration of gravity at the surface of the earth was known, likewise the radius of the earth, through the work of such men as Snell and Norwood, and the distance of the moon had been determined pretty accurately as equal to sixty times the radius of the earth. These were all the data necessary to answer the problem, assuming the hypothesis that it is the earth's gravity that retains the moon in her circular orbit.

Conditions of testing the hypothesis

But in this application of his problem Newton came across a difficulty that was not present in treating the relative distances of the planets from the sun. Since the distances of the planets from the sun are large compared with the size of the sun, it makes little difference whether those distances are measured from the sun's center or from any other point in the sun's body. But when we wish to compare the attraction of the earth on the moon with its attraction on a stone near the ground, it is essential to determine whether we should measure the distance of the stone from the nearest point on the earth, from the center of the earth, 4,000 miles away, or from some other point. Newton assumed for this early calculation that the center of the earth was probably the center of her gravitative attraction on both the stone and the moon.

Its general verification

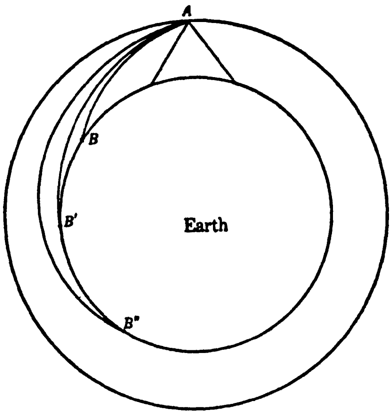
With this settled, it was possible to make the calculation. We know that the moon's distance is sixty times the radius of the earth, and since the circumference of a circle is proportional to the radius ($c = 2\pi r$), the moon must travel in each of her

revolutions sixty times as far as a point on the surface of the earth in the course of the latter's daily revolution. Now we know the distance round the earth to be roughly 24,000 miles, and we know that the moon completes a revolution once in about twenty-seven days. The moon therefore moves about $60 \times 24{,}000$ miles in twenty-seven days, which reduces to a velocity in her orbit of about 3,300 feet per second. According to the formula noted above, therefore, the moon's acceleration toward the earth is measured by the square of this velocity, divided by the distance between them. Reducing the earth's radius from miles to feet, where the figure becomes about 20,000,000, we may express the moon's acceleration as equal to $\frac{3300.3300}{20{,}000{,}000.60}$. This works out to a fraction about 1/110—that is, the acceleration at the distance of the moon should be 1/110 of its acceleration at the earth's surface, if our guiding supposition is right. Now by the law of the inverse square, the acceleration of a falling body at the surface of the earth, which is sixty times nearer, ought to be equal to the square of sixty times this fraction. But $\frac{60.60}{110} = 32.7$. Since the verified acceleration of gravity on the surface of the earth is something over thirty-two feet per second squared, the hypothesis is verified as nearly as could be expected in the absence of more exact figures. The moon is thus shown to be essentially a falling body, and her motion round the earth is a consequence of the same law as is revealed in the terrestrial motions with which Galileo had been experimenting.

**Popular illustration of its meaning**

Newton illustrates his great discovery in terms of the dynamic phenomena now familiar to educated folk by drawing an analogy between the motion of the moon and that of a projectile hurled horizontally from some point on the surface of the earth, such as a bullet shot horizontally on the top of a high mountain. Let the bullet start from A, then under the joint influence of its original velocity and of the earth's attraction it will describe a parabolic curve, reaching the ground at some point such as B. If it were shot with greater velocity the curve would carry

farther to B′ before meeting the ground, for the time it takes to drop to the ground is the same whatever its horizontal velocity. If the velocity were greater still, it would not reach the ground till it had passed around to B″. Now with a little effort of the imagination we can see that, if its velocity were great enough to begin with, and if the resistance of the atmosphere were eliminated, the bullet would miss the earth altogether and describe a circle round it, returning to the same place from which it was shot. Its original velocity, in other words, is just enough to counteract the gravitative attraction of the earth, so that its




THE MOON AS A FALLING BODY

path is always equidistant from the earth's center. This is exactly what the moon does, only she is nearly sixty times as far away as the hypothetical bullet, and her original motion was not communicated by a gun; but once in motion with the appropriate velocity she behaves exactly as a falling body would. Every revolution is a fall toward the earth, but her velocity is great enough so that she falls entirely around and returns to the same point.

Problems still unsolved

Now Newton did not publish these extraordinary results at the time, nor, indeed, for the twenty years and more that elapsed before the immortal *Principia* appeared. The story became cur-

rent that this delay was due to his having used a seriously inaccurate measure for the earth's radius, but there was probably never any real evidence for this supposition save the fact that he repeated the calculation when Picard's improved measurement came out, and found the result more satisfactory than before, though the earlier one, as he later affirmed, answered "pretty nearly." As appears from the history of his work up to the publication of the *Principia*, the main deterrent was the fact that he had not yet proved the validity of his assumption in these calculations that the gravitative force of the earth attracts as though it were concentrated at the earth's center. This he wanted to establish definitely before asserting his theory as verified; accordingly, he laid aside the subject for the time being and devoted himself to further researches in mathematics and optics.[1]

The laws of acceleration verified for an orbit

Late in the following decade, that of the 'seventies, he was induced by discussions with Wren and a letter from Hooke, both of whom were then speculating about a law of attraction between bodies that might vary inversely with the square of the distance, to take up actively the problems of celestial mechanics again. In 1679 he made further discoveries that hastened greatly the complete solution of the problem of the planetary motions and that of their satellites. He had known, of course, that the actual motion of these bodies was in a curve more like an ellipse than a circle. He now discovered that his formula for the acceleration of a body revolving in a circular orbit applied also to an elliptical orbit, provided that the acceleration be directed toward one of the foci, and that the revolution of the body when nearest that focus be at a greater velocity than its revolution when farther away. Calculating how much greater the velocity would have to be at the perihelion and how much smaller at the aphelion for the body to remain without displacement in its elliptical orbit, he found that this condition would be met if the velocity were such that the planet-vector swept over equal areas in equal times. But this was precisely what Kep-

[1] See F. Cajori, "The Growth of Legend About Sir Isaac Newton"; *Science*, May 2, 1924.

ler's second law had stated with reference to the revolution of the planet Mars. Moreover, it followed, conversely, that if a moving body revolve in an ellipse round a central body in one focus, being diverted from its tangential direction by a gravitative acceleration toward that central body, that acceleration must vary in different parts of the path inversely as the square of the distance. In other words, he succeeded in uniting completely Kepler's laws of planetary motion with Galileo's foundations of dynamics as developed by Huygens and himself. Given Kepler's laws, it follows that each of the planets moves with an acceleration directed toward the sun that varies inversely according to the square of the distance, which law he had already found to explain in an experimentally verifiable way the fall of objects on the earth's surface and the revolution of the moon. Conversely, given the foundation of dynamics and the law of the inverse square, and supposing that these laws hold throughout the planetary system, Kepler's laws would have to follow, for only revolutions in accordance with these laws would be consistent with such dynamical principles. For Newton was able to show, a few years later, that Kepler's third law, which had been stated in terms of a normally circular motion for the planets, was equally consistent with Newton's new deductions when the paths of the planets were taken to be ellipses. Such discoveries not only harmonized beautifully Kepler's laws with the central principles of dynamics, but also gave Newton effective tools for dealing successfully with the motions of the comets for the first time.

The remaining problem solved

But again Newton was able to reach, as yet, no satisfactory demonstration of the validity of his assumption of the concentration of gravitative force at the center of the attracting body; moreover, his interest in other problems was strong also, and accordingly the results of his investigations were again not published. But in 1684 Edmund Halley discovered independently the law of the inverse square, as a consequence of Kepler's third law, and having failed to secure help from Wren and Hooke on the question what curve a body would move in if acted on by an attraction varying according to that law, visited Newton

at Cambridge and learned from him the answer. Halley then persistently encouraged Newton to prepare his discoveries on mechanical lines for publication. Newton responded by devoting himself again to the mechanical problems which still pressed for solution, and fortunately in the following year he worked out a demonstration of the assumption which he had as we saw been making when applying dynamical laws to astronomy, as we learn from a letter which he wrote to Halley on June 20, 1686. He then proceeded systematically to organize the material which was published in the *Principia* two years later.

From the mass of demonstrations presented in this epoch-making book we shall select only those which it is necessary to understand in order to see how Newton was led to extend his conception of the law of gravitation to its most universal form.

**Newton's three laws of motion**

The fundamental dynamical assumptions present in the work of Galileo and Huygens Newton formulates clearly in his first two axioms or laws of motion:

*Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.*

*The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*

This law is obviously present in Huygens's attempts to measure the acceleration toward the center of uniform circular motion. Now Newton added to these a third fundamental law of motion, of which only vague intimations are to be found before his time. This law he phrases as follows:

*To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.*

**The third law leads to the conception of center of gravity**

Newton's first illustration of this law clearly shows its essential meaning. "If you press a stone with your finger, the finger is also pressed by the stone," and, of course, the pressure is equal from whichever side you view it. In other words, this law is a general statement of the relativity of all mechanical relations. When you hold a stone on your hand, the pressure is the same

quantitative fact whether you state it as a downward pressure of the stone against your hand or as an upward pressure of your hand against the stone. The tension between the two may be described either way. Now when this idea is generalized in the law of equality of action and reaction, its application to astronomy leads to the significant notion of the *center of gravity* of a system of motions. The earth, for example, attracts the moon toward itself with a certain force. But the same fact may be expressed from the other end; the moon attracts the earth with precisely the same force. Or more precisely still, we mean by gravitational attraction between them a relation that is entirely mutual, and which is expressed by the same quantitative statement from whichever side we view it. The most obvious and interesting fact which shows that the moon thus does attract the earth in the same way as the earth the moon, is the phenomenon of the tides, where the fluid masses of water, cohering less strongly than the solid earth, are pulled toward the moon when it is opposite them. Accordingly, Newton sees that it is not quite correct to speak simply of the moon revolving round the earth; rather, the two bodies together constitute a system which revolves round their common center of gravity. But because the earth is vastly bigger than the moon, this common center of gravity is never very far from the earth's center, and hence while our common mode of speaking thus receives a certain justification, perceived irregularities in the motions of the planets with satellites are also beautifully accounted for. As applied to the solar system as a whole, of course, this principle means that the sun is attracted toward each of the planets with the same force whereby it attracts them, and that its position is nearer the center of the whole system on account of its greater bulk; but the entire group constituted by the sun and the planets does not revolve round the sun, but around their common center of gravity. The distance of this center of gravity from the sun's center varies in accordance with the position of the several planets, but since the sun is more than three hundred times bigger than the largest planet, this distance never very much exceeds the diameter of the sun. In the light of this conception

gravitational attraction no longer appears as a property peculiar to the central body of a revolving system, but is seen to belong to all bodies in precisely the same way—it is the expression of a fundamental relation between them.

The problem of gravitation in its general form

But how now shall we state the law of acceleration expressing this attraction in its most general form? How formulate numerically the behavior of this universal gravitation? It is here that Newton needs the basic conception of mass, to which he first gave clear definition, and the demonstration of the legitimacy of his assumption that the attractive force of every body is exerted as though it were concentrated at the center.

Discovery and significance of the concept of mass

Before Newton the conceptions of mass and weight had not been clearly disentangled from each other. This was because on the surface of the earth the masses of bodies are always proportional to their weights, and because nobody had realized fully the implication of the new idea (which indeed before Newton had not been clearly grasped and verified) that the attraction of the earth or any other central body on an object varied in accordance with its distance. But the weight of any object is simply the attraction between it and the earth at the surface of the latter. This idea, coupled with the Cayenne experiments and certain others on mountains and in mines, made it necessary to distinguish clearly the weight of a body, which varies in accordance with its distance, from another quality which is related to its weight but which must be constant whatever its distance from other bodies. This constant quality Newton calls the *mass* or *quantity of matter* of the body. That there is such a constant quality is revealed by many experiments, both of daily life and of science. Hang up a punching-bag by a strong cord. The attraction of the earth is now counterbalanced by the cord, but yet we find very soon that some punching-bags interpose much greater resistance to our punches than others, and that this resistance is proportional to their weights. Here is a quality of the bag which is evidently independent of its relation to the earth, and which we perceive would belong to it wherever it were placed. Bring a certain definite force into play upon the bag, and the latter will be given a certain

definite acceleration, measured by that force, wherever it may be; furthermore, it is evident that this resistance to being set in motion is quite independent of the size of the object. We can easily hurl a pillow, but it takes considerable effort to set in motion a rock of the same size. Hence this constant quality or mass of an object is measured by the acceleration imparted to it by a given force, or conversely, the force operating upon it is measured by the product of the mass and the acceleration it receives. Since the weight of an object at the earth's surface is nothing but a measure of force by which the object and the earth tend to come together, and since the earth is constant for all such objects, weight is always proportional to mass.[1]

**Difference and relation between mass and weight**

We may clarify this relation of mass and weight in the following manner. Suppose a body to rest on a support, on which by its weight it exerts a pressure. It appears to be an obvious inference that two or three such bodies, or one-half such a body, will exert a pressure two, three, or one-half times as great. Accordingly, the downward pressure against the support varies according to the quantity of matter or mass of the body, precisely as its resistance to being set in motion varies according to the same quality, for the support is restraining its acceleration toward the earth just as a punch when it hangs on a rope communicates acceleration to it. We see also that if the acceleration toward the earth is increased, diminished, or vanishes entirely, the force expressed in its weight would increase, diminish, or vanish entirely. It is thus evident that the force varies quantitatively according to the product of mass into the acceleration of descent—$F = MG$. Suppose now we have two bodies that exert respectively the weight-forces $W$, $W'$, to which we ascribe the masses $M$, $M'$, and which are subjected to the accelerations of descent $G$, $G'$; then of course $W = MG$, and $W' = M'G'$. If now we proved that independently of the chemical composition of bodies, $G = G'$ at the same point on the earth's surface, we should obtain the result that $M/M' = W/W'$; that is, on the same spot on the earth's surface, mass is proportional to weight and can be measured by it. Newton then proceeded to

[1] Disregarding equatorial bulging and minor irregularities.

establish the fact that G is independent of the chemical composition of bodies by a series of careful experiments with pendulums of equal length but different material. It was necessary, of course, to allow for the resistance of the air, which he did by constructing spherical pendulum-bobs of exactly the same size; the weights were equalized by appropriately hollowing out the spheres. All bodies were thus shown to be affected with the same acceleration, and it followed that their masses could thus be measured accurately by their weight.

Thus through the Cayenne experiments and the extension of dynamical principles to astronomical relationships, the conception of mass as a constant, quantitatively measurable quality of bodies, determinative of accelerations in relation to other bodies, was clearly distinguished from weight, and became a basic conception in mechanics along with space and time. How did the clarifying of this conception affect the formulation of the law of gravitation?

In the first place, it made possible a quantitative statement of the position of the center of gravity in any moving system. Consider the mutual relations of Jupiter and the sun, for example. The third law of motion indicates that the sun is drawn toward Jupiter in exactly the same way as Jupiter is drawn toward the sun. But the sun interposes greater resistance to that mutual attraction in proportion to its greater mass, just as a punching-bag interposes resistance to a blow in accordance with its mass. Since now the sun's mass is 1,047 times that of Jupiter, we have a definite quantitative ratio of the distance from each of them of their common center of gravity.

**It makes possible a functional statement of universal gravitation**

In the second place, it becomes evident that the apparent constancy of the law of acceleration at the surface of the earth for all bodies is due simply to the fact that the earth's mass is so much greater than that of any of the bodies with which we experiment that in comparison with it their own mass-differences are negligible. In reality the earth shows less resistance to the attraction of the falling boulder than it does to the falling pebble, and therefore the law according to which they move together is not exactly the same. The masses are

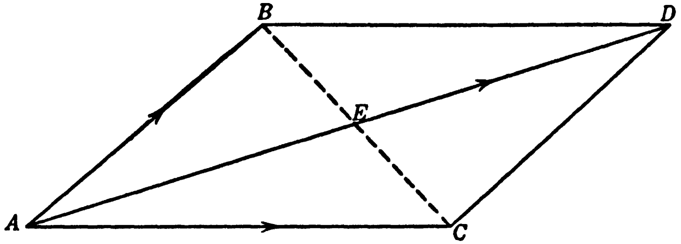
different and therefore the accelerations determined are different. We see this clearly, once the conception of mass has emerged, if we consider the relations of the earth and the moon. Suppose the moon's mass were greater than it is, its velocity remaining the same. Then its resistance to the earth's attraction would be greater; in a given period of time it would fall toward the earth less than it now does, and therefore it would recede from its present orbit to a greater distance from the earth. Similarly, if its mass should become less, its resistance to the earth's attraction would diminish and it would move from its orbit toward the earth.

These considerations mean that we may now formulate the law of gravitative attraction between any two bodies as varying not merely inversely according to the square of the distance, but also directly in accordance with the masses of the two bodies: $G \propto \frac{M \cdot M_1}{D^2}$. The larger the masses, the greater the acceleration, and *vice versa*.

Necessity to the formula of the parallelogram of forces

It remains now to note Newton's proof for the assumption that the attractive force of every spherical and physically homogeneous body is exerted as though it were concentrated in a single particle at the center. The bulk of this proof is given in Propositions 70 to 76 of the first book of the *Principia*. We shall not repeat the entire proof as Newton gives it, but note simply that it depends on the theorem of the parallelogram of forces, which in turn goes back to Galileo's basic assumption that bodies moving under the play of different forces act as though those forces were entirely independent of one another. If this is true, then a body A acted upon by forces comparable with AB and AC in quantity and in the direction of B and C, respectively, will in the time these forces have acted upon it reach the point D of the parallelogram ABCD. For the one force will have carried it to B, and the other force will have carried it to D along a line parallel and equal to AC. It is evident now from the relations of parallel lines that A will move in a line which intersects BC at a point equidistant from B and C, and this point of intersection will also bisect AD. But this means

that if the forces in question are the gravitational attractions of B and C, respectively, A will move as if their combined gravitative force were concentrated at this point E equidistant between them.




THE PARALLELOGRAM OF FORCES

Now a sphere may be regarded as a collection of an infinite number of particles, for every given one of which there is another equally distant from the center of the sphere and in the same straight line. Every such pair of particles will therefore attract an external body as though the two particles were concentrated at the center of the sphere. And since the sphere can be exhaustively analyzed into such pairs of particles, it will attract any other body as though its entire mass were concentrated at the center. By similar principles Newton demonstrated that a body not spherical, or not homogeneous in substance, would attract another body as though its mass were concentrated in its center of gravity.

**Final statement of gravitational attraotion**

Such theorems freed the conception of gravitational attraction from all limitations, and made it possible to express it in its absolutely universal form, as a law of behavior revealed throughout the entire material world and explaining completely the major facts of the sciences of astronomy and mechanics: *Every particle of matter attracts every other particle with a force proportional to the product of their masses, and inversely proportional to the square of the distance between them.* For larger bodies this means that each such body attracts every other body with a force proportional to the product of their

masses and inversely proportional to the square of the distance between their centers of gravity. And in the case of a homogeneous sphere that center of gravity is identical with its geometrical center.

Thus reached its culmination a marvelous chapter in the history of reflective thinking, a chapter that still stands forth as the most remarkable conquest of nature by the human mind in its long and halting struggle to reduce its world to precision and order. The most constant and familiar motions of the objects with which we deal on the surface of the globe, together with the vast motions of the celestial bodies, were now shown all to follow from a simple, comprehensive, quantitatively formulable law. There is no other chapter yet in the romantic adventure of the human mind that can quite compare with it in brilliance. A vast and important province of nature's empire was thus, within the course of a hundred and fifty years, completely reduced to a mathematical system, permitting a degree of exact understanding, prediction, and control that would earlier have seemed entirely fantastic. No wonder that Locke, England's greatest philosopher before the days of Hume, designated himself as beside the "incomparable Mr. Newton, an under laborer, employed in clearing the ground and removing some of the rubbish that lies in the way to knowledge",[1] nor that Pope wrote as a couplet for Newton's tomb in Westminster Abbey:

> Nature and Nature's laws lay hid in night;
> God said, "Let Newton be," and all was light.[2]

**Further illustration of the principle of parsimony**

If now we return to the issue between Copernicus and his contemporaries, the place in scientific advance of the principle of parsimony wins a clearer revelation. Suppose, after Newton's achievement expressed in the universal law of gravitation, one should venture to maintain that perhaps, after all, the earth really is the astronomical center of the universe? By complicating Ptolemy's scheme with the addition of many more epicycles, it would still be possible to represent the known facts geometrically on the geocentric basis. But in order to maintain

[1] *Essay Concerning Human Understanding,* Epistle to the Reader.
[2] *Poetical Works,* Glasgow, 1785, II, 342.

that supposition now it would be necessary not only to treat as mysterious accidents the facts which Copernicus and Kepler found could be beautifully explained from the solarcentric assumption, but likewise the complete coincidence which had now been shown to hold between the laws of terrestrial dynamics established by Galileo and Huygens and the laws of the astronomical motions would have to be considered a sheer collection of accidental circumstances; moreover, the continued mastery of more and more data in terms of the same basic assumptions would become an inexplicable piling of accident on accident. The fact that no human mind can really hold to such a point of view if it faces frankly the facts and desires to comprehend them, is ample testimony to the validity of the principle of parsimony as universally determining our way of interpreting the world. Where scattered and otherwise accidental facts obviously fall into unity in terms of a certain hypothesis, how can we avoid that hypothesis as furnishing their explanation? For to explain is to reduce the contingent to the unity of law. It is accordingly correct to say not only that a theory is verified if it accounts for the facts, but also that, as between two theories each of which accounts for a certain group of facts, that one is to be accepted which accounts for them in such a way as to bring them into unity with as many other facts in other fields as possible, so that the mind may be able to embrace and control the largest mass of fact in terms of the fewest necessary assumptions.

**Transformation of Copernicus's original hypothesis**

To think of the sun moving round the earth thus now becomes inconsistent with the very foundations of our mechanical knowledge. But it is interesting also to observe that in this expansion of scientific thought the original novel assumption of Copernicus becomes itself somewhat transformed. For it appears that the sun is not, after all, the center of the solar system —to say nothing of the universe as a whole—though it is many hundred times nearer that point than the earth. An entirely new conception has developed of the center of gravity of a system of moving bodies, and it is around that center of gravity, which at times is entirely outside the body of the sun, that the solar

system revolves. Such a transformation of an original leading assumption in the light of the new facts which it helps to harmonize and the new conceptions to which it gives rise, is exemplified in every important chapter in the history of science. This is of especial interest in our day in view of the fact that now many of Newton's major assumptions have proven themselves antiquated, and are in solution awaiting replacement by more inclusive and empirically defensible notions.

**Parallel advance in mathematics**

It should be observed also, before we leave this conquest of early modern science, that one important attendant line of development is being left out of the account. To present it adequately would be impossible without assuming a knowledge of the higher branches of mathematics on the part of the reader. Yet it was really an indispensable aspect of the development, for though Newton chose, for the sake of his contemporaries, to express his results in traditional geometrical form, he could hardly have arrived at all of them by the traditional mathematical technique. When Copernicus wrote, the mathematical methods available were not really adapted to deal successfully with problems of motion. Kepler, Galileo, Descartes, and Newton found it necessary to build up a new type of mathematical analysis for the effective handling of problems of motion, which in its essential meaning could not be represented by the old geometrical forms. Mathematics itself had to become dynamic rather than static in its structure. The two greatest steps in this aspect of the transformation were the analytical geometry of Descartes and the infinitesimal calculus of Newton and Leibniz. We cannot attempt to analyze these in detail; it will be sufficient to note that such mathematical discoveries first made possible the application of exact quantitive analysis and comparison to the kind of problem into which thinkers were being led by the new dynamical inquiries.

Exercise.—The best method brought to light in the author's experience of securing practice in the entire process of scientific discovery and formulation (outside of long and intensive laboratory work), beginning with the chaotic experiences which demand explanation and ending with the statement

of an explanatory law in functional form, is found in the solution of cryptograms.[1]

(a) Solve the cryptogram and state its key in the form of a functional law, such as: "Substitute for each letter the third following letter in the English alphabet," "Read for each vowel the following vowel, for each consonant the letter equally distant from the letter m," etc. Some of the keys will be very simple, some rather complex, but all can be stated in functional terms.

(b) Analyze the thinking by which the solution was reached in terms of Dewey's five steps, showing precisely what parts belong in each step.

(c) State how the more general scientific principles of empiricism and parsimony, and the assumptions of agreement and difference, are revealed in your procedure. (The principle of parsimony will usually be revealed in such a form as this: "If I follow this key I can make sense out of all the words but two, and those two will have to be regarded as following another key, or as being accidental mistakes. But if I follow that, sense can be made out of the entire sentence. Hence the latter is the true explanatory key.")

The first seven cryptograms are separated into words, each of which represents an English word. In the last three the interpretative units themselves must be ferreted out by the student. In dealing with them he is thus in a situation fairly comparable to that of the archæologist attacking an inscription in an unknown tongue, or a Newton first disentangling the conception of mass, in terms of whose units he proposes to reduce the material world.

1. WLUH GSU NLIGZI SLOW GSU YIRXPH GLTUGSUI LI PUUK GSUN ZKZIG?
2. KE FKO QOYREQ DKIQ QOYREQ MUHK.
3. 50 =O =6E A9= =60U %7U55A#3 209%13E# 6E# ;A¢% A93 1E ;1%E ;1626 6A"195 9O O"E#%EE# O# O# #U7E# ?#O"13E=6 6E# 1#EA3 19 =6E %U88E#.
4. NVUROKONVE UPHORHYK JUY CNNRUASJUOP OX LYXRYAJUHY JVOIWVJ JO JUY XIPXCQYPJCR PCJILY CPZ YKKYPJVCR KUWPUXUACPAY OX LYCRUJE UP WYPYLCR.
5. ARCSJ M AAABZ YKNZUQRDJHIBM RF QBA BIYEG PTJ

[1] My friend and former student, Professor C. M. Perry, of the University of Texas, first called my attention to the possibilities of cryptograms. He has used them to great advantage in the teaching of scientific method.

DTRG XX OYBHECFVIQ CVIAJRFD, QA PUYZRQ, UW HHR RNULHZ, PO ATR AQNR FBQ RLP NNWIUUAT.

6. 3-11-10 3-11-15-13 22-11-6 4-24-10-14-7-6-10 26-16-16.
7. CHABHJQZAH QFZVXZYBG XN MYB QORDBNN XSCLUZHI ZV KM LBB WHV UA FSH XSMPUUXZBSDB.
8. VIXVIXVIIIVIIIXIVXXXXVIIIXXIVXXIVXVIIIXXVIIIXXX XVIIIXXXVIII
9. ZOOCBVCDLIPHCLUCGSVCOLIWCKIZRHVCBVCGSVCOLIW.
10. UVCLXCHNBYBUNXCMQILNBNQICHNBYVOMB.

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*Part IV*

# PROBLEMS OF RIGHT THINKING IN EXTRA-SCIENTIFIC FIELDS

CHAPTER FOURTEEN

## FACT VS. VALUE

Our think not limited to the realm of objective knowledge

WERE it desirable to terminate our analysis with matters which when thus systematically stated are fairly obvious and in the main beyond dispute, we should end the volume without embarking on anything further. But the student has a right to know that in discussions about right thinking, as about everything else of especial importance in life, there is a wide realm in which accepted norms of reflective method are decidedly not yet established, where logic, in short, has not yet gained many inches of ground that it can confidently call its own. The realm of science is not coextensive, that is, with the total realm with which we endeavor to deal in our thinking. We think, and indeed find it the highest importance to think as best we can, about matters of morals, religion, social policy as expressed in law, aesthetic objects, where it is perfectly evident that objectively demonstrable standards of right thinking are not present. People who could be quickly brought to entire agreement about a matter that could be subjected to scientific experiment, differ widely in their opinions about these matters and as soon as general agreement is reached on some questions in these fields new divergences appear on others. Is there a God? Ought we to recognize the Russian Republic? Is the prohibition amendment a good thing? Is Drew a greater actor than Sothern? It is clear that one does not need to go far to find questions through which we try to think our way, but in which it is difficult to discover any objective standard for our thinking comparable to that which the procedure of scientific verification offers. What shall be our policy in dealing with this extra-scientific realm? To neglect it would be to fail in frankness and candor, to give the

impression that all in logic is settled, when it most assuredly is not. Shall we offer dogmatically our own answers to these unsettled questions, hoping in his unguarded moments to make a convert of the reader? That would surely violate the experimental, forward-looking, and frankly coöperative atmosphere with which our discussions have been surrounded throughout. But there is one other alternative. Let the insistent challenge which these baffling puzzles involve for the teacher of right thinking be freely shared with his students. Let them be taken with us to the outposts of exact knowledge to survey the more or less chaotic field beyond. Sooner or later the responsibility will be theirs to do what they can with this problem—let the difficulties be clearly faced now.

Why special difficulties for right thinking when we pass beyond science?

What is the reason for the presence of special logical difficulties in our thinking about these extra-scientific problems? We find ourselves at once in the morass through which we are now to wade when we note that there is great disagreement about the proper answer to even this question. It forms, in fact, one of the most hoary and puzzling questions of metaphysics, and metaphysics, as we shall see in one of the subsequent chapters, is itself one of the realms in which objective logical standards have not yet been established. Accordingly, our procedure in dealing with the difficulties of right thinking in these fields must from the start be wholly exploratory and democratic. We must survey the situation with as complete impartiality as we may, and even such principles as we accept for purposes of systematic guidance must be set forth with entire tentativeness; the student must recognize that they are not at all comparable in objectivity to the principles which empirical science reflects. Only if they are to be taken in this manner would it be permissible to introduce and use them.

Nevertheless, some such tentative assumption must be followed through the ensuing chapters if the discussion itself is not to be as labyrinthine as the chaotic realm which forms its object, and leave the student no profit whatever from its perusal. We must at least clarify the issue for purposes of subsequent consideration and debate, and this means that some reason must

be suggested for the logical differences between scientific and non-scientific fields of thinking, which may be used to unify the discussion sufficiently to achieve something of this clarification.

Suggested answer—such thinking involves a unique type of valuation

The reason offered by the author in this tentative way as a principle of guidance is that thinking about these extra-scientific matters involves a process of valuation in a form in which such valuation is not present when we are dealing with the realm of what we call scientific fact, and that it is in certain peculiarities of this process of valuation that we are to find the main (though perhaps not the sole) explanation of the logical bafflement there faced. Let us see in a preliminary way in the present chapter some of the considerations that can be offered in support of this supposition, and develop briefly their corollaries. The hypothesis is stated thus frankly and early so that the reader may be encouraged to consider, while perusing the subsequent chapters, what phases of his experience tell against its validity, as well as the extent to which it offers an illuminating interpretation. We have passed beyond the realm of objectivity; our aim now is to attack very important problems together.

First, what is a *value,* and how does it differ from a *fact?*

The common-sense distinction between fact and value

Without embarking upon dangerous metaphysical discussions about the ultimate relationship of fact and value, it is sufficient, to begin with, that there is a common-sense distinction between them, recognized by all normal people, which we quite take for granted in our thinking, and that certain problems do appear in dealing with values that perplex our attempt to establish norms of correct thinking far more than is the case when we are dealing with facts. Let us take a concrete case that will reveal the difference. Suppose we wish to compare Chicago and New York in various ways. Which is west of the other? Which is higher in altitude? Which is more northerly in latitude? Which is colder in the winter? Which has the larger population? To these and a host of similar questions we can get answers that are definite and objective, so that whatever our partisan feelings may be about these cities, the way in which answers to these questions are to be reached and the validity of the results, are

matters on which we easily find agreement. Such questions are, in short, questions of fact, and facts seem to have a compelling objectivity about them which forces our agreement. But suppose we raise the further question: Which is the better city to live in? Can we answer such a question so easily or so confidently? You or I might be able to answer at once which we individually prefer to live in, but we should recognize that the factors which we rated highly in the comparison would not be rated so highly by everybody; in a given discussion about the matter every fact introduced might be agreed upon without dispute, and yet diverse answers be given on the issue of valuation. In short, this is a question of value, not of fact. How are we to proceed to think correctly about such questions?

**Value as affecting our thinking always the object of desire**

Before beginning an analysis of what these questions involve for logic it is again desirable to enter demurrers about possible metaphysical embarrassments. It is our business to remain noncommittal, so far as we can, on any ultimate theory of the nature of fact or of value. We find ourselves attempting to think about both. The principles of right thinking about facts have been under discussion in the previous pages and we have not been intentionally subscribing to any doctrine about their ultimate status. We must preserve the same metaphysical aloofness in the present section. Value may be objective or subjective, grounded in the structure of the universe or a transitory function of human desire; it ought to make no difference for logic. But we have to note that all its familiar forms, at least, are intimately related to human want or interest, and that, therefore, when we are thinking about value concretely we are always thinking about something that is wanted or attracts an interest—is valued, in brief. It is difficult to see how we could attack the problem of correct thinking about values at all unless we were allowed to proceed on this basis. For it is only as objects of interest that we can empirically discover values functioning in our thinking, and it is how to deal with them correctly as thus empirically functioning that we want to know. About values that are not valued any thinking might be either correct or incorrect—who can tell?

We shall assume, therefore, that the problem of right thinking about values is the problem of thinking truly about things that present themselves as good and bad in the course of our own and other people's ordinary experience. But now if we proceed on this assumption we must remember the statement made in chapter three that reflective thinking is always purposive, always functioning in the interest of some desire. This is to say that it is always instrumental for the realization of some value, is always, in every use of it, a process of valuation. What becomes then of the distinction we are now insisting upon between fact and value? If facts themselves function logically in a process of valuation, what kind of valuation is it that interposes special difficulties for right thinking which we do not meet when applying scientific method to the realm of facts? And just what is the relation between fact and this process of valuation which appears from these considerations to be logically more inclusive?

**But all thinking is controlled by desire**

To answer these questions we must take a second step. Let us drop these conceptions of value and fact for a moment, and simply consider on their own merits two types of thinking which will emphasize a rather basic distinction between the conceptions of end and means.

**Distinction between reflective selection of means**

If I try to think my way through the problem, What is the cheapest way to travel to England? I find that the fifth step of the act of thought thus embarked upon takes a peculiarly definite and final form. The problem resolves itself into collecting data from the steamship companies that cross the Atlantic and comparing the cheapest modes of passage offered by all of them. That comparison is guided by a definite purpose which remains fixed for the entire act of thought, namely the purpose of finding the cheapest mode of transportation to England. Accordingly, when, with all the data before me, I discover that one of the companies offers third-class passage at a rate slightly lower than that of any of the other companies, I have found a specific and irrefutable answer to my problem. What I have thus discovered is an objective fact, and whether I proceed to carry out my

notion of traveling by this route or not, I can prove to anybody that this is the only correct answer to the question raised.

And reflective determination of ends

But suppose I am the recipient of an attractive offer to take a presumably permanent position of a somewhat different sort than the one I am at present filling. In my attempt to reach a decision on this question no such specific and fixed purpose controls my thinking. Of course, there is a certain element that is common between this purpose and the one just cited—in both cases I want to attain the best solution—but this common element between the two purposes is hardly more than highly abstract and verbal. No purpose that is fixed in any more limited and definite way is functioning here. And accordingly, by no such simple comparison of given facts can I reach a demonstrable and unambiguous conclusion, such as was apparently possible in the other act of thought. Rather, it is only when I go through the process of elaborating the bearings of the alternative choices and comparing them with each other in the light of such deductions, that a guiding purpose first emerges in definiteness and clarity; it did not exist in such a form before. I find that the fourth step of the act of thought, in this case, consists of developing a pair of pictures of my possible future life, each picture composed of the entire group of imagined consequences which spread out before me as involved in one of the alternatives. I say to myself: If I accept the offer—then larger salary, with all that that would mean for my family, a more healthful climate and environment for my children (both of which matters I elaborate further in imagination); but on the other hand the work will not be nearly so congenial, nor will I have the same opportunity for a lengthy period during the year devoted entirely to research along the lines of my greatest interest. If I remain—of course the converse of these deductions, together with certain other considerations respecting plausible hopes for larger financial return from my present work in the future, etc. These pictures I elaborate in imagination, striving to expand them as fully as possible and to control the expectation of consequences rigorously in terms of past experience, until one of the two pictures appeals to my entire nature definitely

more than the other. In deciding then to make the choice that implies one picture rather than the other, I say, this is the better alternative of the two—and it is only at the end of this process of elaboration and comparison that the definite purpose to live a certain type of life rather than another emerges into clarity and is able to control more subsidiary problems.

**In the former, the end is already known. In the latter it is to be created**

What is the fundamental difference between these two thought-situations? Clearly, that in the one case a specific purpose governs the entire piece of thinking; the fifth step is accordingly simply a matter of measuring different alternatives in the light of that purpose and selecting the one that most nearly meets its clearly stated condition. In the other case, a specific purpose emerges into being only as a result of the thinking itself; the goal of the latter is just to bring that purpose into being. In different terms we may put the matter thus: In the first case we know what we want all the way through the act of thought, a certain definite value is taken for granted; while in the second case we are trying to determine by the act of thought what we want, no value is taken for granted except the abstract one of making the best decision, but the controlling value is to be created by the thinking upon which we engage. We express this in technical terms of value-theory by saying that in the former situation the *end* of thought is clearly known and assumed, the purpose of the thinking being merely to select appropriate *means* for its attainment, whereas in the latter situation the end itself is in question, and the purpose of the thinking is precisely to give it shape and make it known. I assume that I definitely want to know the cheapest route to England; what I want to do about the offer of this new position is exactly what my thinking tries to decide.

**The former includes the realm of factual knowledge**

Now it is important to observe that what we call facts appear as results of our thinking only when we are in the former of these two sorts of problem. Their objectivity and demonstrable character seem to be connected with the fixity and definiteness of the controlling purpose; in so far as that purpose is clear and accepted by all minds that are dealing with the matter in question, the data involved gain objectivity of fact, too. Given

the end as known and assumed, the means that are necessary to attain it must be accepted as such with the same finality. In the case of the scientist this known and assumed end is what we call *truth;* granted a clear notion of what this concept means, and its desirability, the terms and relations which can be shown to be demanded for its attainment in this or that field of experience become what we call hard or objective facts. To say this is not necessarily to commit oneself to the doctrine that were there no active pursuit of truth there would be no facts. It is to recognize, however, that this is the way facts function in our thinking, that apart from the truth-seeking purpose, or a purpose of which truth-seeking is a necessary aspect, nothing does acquire in our thinking the objectivity and dependability of what we call fact. Granted, for example, an interest in the cheapest route across the Atlantic (which interest involves the demand to know which of various routes is cheapest), and the result of the thinking gains factual character—this or that route *is* the cheapest.

**Because the end of science is clear and shared by all**

How is it, then, that in scientific thinking it is possible to establish objective standards of correct procedure, standards which impress themselves as sound upon all who see what it is that the scientist is trying to do? Fundamentally, it now appears, because the purpose of simply understanding how things happen is a purpose which all of us find ourselves sharing on so many occasions that the nature of this purpose and the necessary methods of pursuing it at once approve themselves to us when they are clearly stated. A coöperating factor is also doubtless to be found in the empiricism of science, noted on several occasions, that is, the method of dealing fundamentally with objects and events which can be pointed out to the sense-observation of other people in the same definite character which they reveal to our own. By holding fast to the purpose of impartially understanding the world, and by keeping its concepts and methods close to the foundation of empirically indubitable events, science secures the objectivity which marks off its application of the principles of right thinking from their use in those situations where the controlling purpose itself has to be created. That the

factor of empiricism, however, is not as important as that of a clearly shared purpose, is shown by the consideration that many matters that are not empirically verifiable appear objective if they are demanded by the scientific purpose, such as the central principles of deduction, while an object of the senses is ambiguous if we do not agree as to how it should be viewed, as the vision of the mystic enthusiast.

Throughout our discussion of the conditions of right thinking we were keeping in mind the assumption which has now been specifically formulated. In some practical problems, as we saw, the end desired is fairly definite all through the course of thinking, and the only difference then between the fifth step and that of a scientific question is that the problem is not important enough to demand exactitude or pressure of time fails to permit it. But in many the end is not definitely formulated in advance, and it is the logical problem related to these that we are now endeavoring to analyze more fully. It is the problem of correct thinking when the function of thinking is to discover and formulate its own controlling values.

The distinction between these two types of [illegible] relative

Nevertheless, if reflection is always concerned with the realization of values, we must say that this distinction between problems whose end is definite and problems whose end is not is a relative rather than an absolute distinction. Let us see how this is so. Even in theoretical problems truth as the guiding end enlarges in meaning and changes in value as we pursue it, and in no practical problem is the end which controls thinking at the beginning immovably fixed throughout. This is frequently revealed in our reflective experience. For example, I might raise the question of the best means of transportation to use for meeting a business engagement, with the purpose in mind at the beginning of using that route which would bring me to my appointment most quickly. This would, let us say, be the elevated train. But before I decide, it occurs to me that it is a fine balmy day in spring, just suited to a ride on the top of the bus; moreover, that in this case no one will be inconvenienced if I arrive ten minutes late. Accordingly, I decide to go on the bus. Now here it is evident that the controlling end has

become enlarged and given clarified shape in the course of the thinking. At the start it was the end of meeting the appointment as quickly as possible. Later it was the end of meeting the appointment by as enjoyable a ride as possible, so long as not much time was wasted and no one was inconvenienced. This forms an intermediate stage between the two cases above illustrated, and it would not be difficult to discover further intermediate stages also. One of these is perhaps important enough to mention. That would be the case where the end remains fixed so far as concerns the terms in which we describe it, but where those terms expand in meaning as a result of the thinking process. It would be safe to say that no patriot has ever thought seriously how to realize liberty or democracy in human life without enlarging somewhat his conception of the meaning of these ideals so that at the end their connotation was far from identical with what it was at the beginning. There is no absolute break, in other words, as we pass from the extreme of a definite controlling end that seems to stay quite put through the act of thought, to the extreme of the situation where we can tell practically nothing about what we want before the thinking is well under way. None the less, it is evident that both extremes really occur in the course of our experience and that the logical difficulties of the one are vastly simpler than those which face us when we consider the other. Once we have passed beyond the point at which the average person can at once share the purpose guiding us and begin to refer to objects which cannot be pointed out to the five senses, logical objectivity seems to fade away and we cannot tell confidently what right thinking means or why we believe what we do.

**Why not confine ourselves to factual thinking?**

But, it might be asked, why not confine ourselves to thinking about facts, where exact standards, accepted by all competent thinkers, can be set up, and eschew thinking about these vague and tantalizing values? A little consideration, however, will reveal the impossibility of such a program. We do not always know, when we begin to think, just what we want, and oftentimes when we think we know, we discover in the course of our further experience that we did not know so clearly, after all.

Moreover, as we look back upon previous experiences we see that many times when we were most confident of what we wanted we were really most mistaken as judged by our present more reflective desires, and this leads us with enlarging reflection to take our desires yet more tentatively and to be more ready to raise the question, in any problematic situation, whether what we think we want does not need to be corrected and expanded by the thinking upon which we embark. In other words, the lesson of experience, intelligently considered, is not to abandon thinking about values, however difficult it may be, but to think about them more earnestly and persistently. We see, to put the point still more emphatically, that it is far more important to reach correct results about what we really want than to reach correct results about what to do in order to attain what we want; the mistakes into which we fall in thinking about the latter are far less crucial and affect our lives less vitally than mistakes in thinking about the former. If I am in error, for example, in the attitudes I take for deepening friendships with others, this error is less fundamental than the one I should be committing if I were mistaken in supposing it a good thing to deepen friendships—in that event my controlling purpose itself would be wrong.

**Reflective determination of ends primary and unavoidable**

It is pertinent to apply this consideration to the scientific situation, for the person who champions fact-thinking as against value-thinking usually means that we ought to confine ourselves to thinking about the data of scientific analysis and make no attempt to transcend such data. In the light of the above remarks is it not evident that this would be simply to assume unreflectively that the end of science is the supremely valuable end? But suppose we were mistaken in this assumption? That a mistake on this point is possible is evident when we note that there are millions of people in the world who in face of a conflict at certain points between religion and science unhesitatingly choose the former. How then can we proceed to justify such an assumption unless we are ready to think about values as well as about facts? For apart from such thinking our assumption would be one blindly and dogmatically,

instead of intelligently, held. Surely this situation will hardly satisfy one who is genuinely eager to think aright and has caught the open-minded and tentative attitude of science. Thinking in the sense of determining values is the primary and inevitable type of thinking. If it is important to think correctly about means, about facts, it is a yet more important and equally inescapable responsibility to think correctly about ends, about what we ought to do with these objective facts. For we shall do something about them whether our controlling ends be reflectively considered or not. As we pass, in brief, from scientific thinking to the thoughtful determination of ends, we not only pass from that which is relatively easy to that which is very difficult and imposes a baffling challenge, but also from that which is relatively unimportant to that which is absolutely fundamental if living in its broader demands is to be made intelligent. Surely this is not a small reason for including a treatment of thinking in the realm of values in a general discussion of right thinking, whatever the logical chaos encountered!

**Vagueness inherent in such valuation**

Let us develop the main corollaries of this distinction and relation between reflective determination of ends and the selection of means to a clearly understood end, such as truth. The first and most basic of these corollaries is that while those terms by which we describe things which usually function as means in our thinking can be given exact and precise meaning, those which usually function as ends cannot in the nature of the case be given a precise meaning. This is a very important point. That it is so will become clear if we consider a few implications of the value-situation outlined above. For a thing to serve as a dependable means for the realization of anything, it must be something that can be objectively pointed out and controlled; it must, accordingly, be clearly analyzed out from its environment, its modes of behavior under different circumstances must be known and definitely made a part of the meaning of the name by which we describe it to ourselves and others. This is why, as we saw, science holds so strongly to an empirical method. But a thing which functions usually as an end rather than a means can have no definite or dependable meaning. Especially is this the

case with the more abstract and general ends which almost never, or never, serve as means at all. This is for the simple reason that when we are thinking about ends we do not know exactly what we want, but are trying to find out by the thinking itself; accordingly, the terms which we use to describe these ends are essentially vague and fluctuating in their connotation; *their meaning has to be given them anew in every act of thought in which they function as end.* If we should succeed in giving them precision of meaning they would become dependable means rather than vague ends, and the question would still arise, to be dealt with reflectively as best we could, for what ends we should then proceed to use them. Since these assertions demand some clarification, let us dwell upon them a little.

We have here the fundamental reason, of course, why the terms which describe our larger ideals of life are so treacherously wabbly in their meaning. Most vague of all are the very abstract conceptions "good," "satisfaction," "happiness," etc., under which we try to include all other ends and which in some sense we are always pursuing in every problem. Next in order come such broad ideals as liberty, democracy, duty, loyalty, beauty, health, and the like, which are almost as elusive in their connotation, but not quite, inasmuch as we do succeed somewhat in limiting their meaning to certain realms of value and occasionally treat them as subordinate to further ends, such as the ones above named.

**Illustrated by the concept of health**

It will be helpful to take one of these concepts and examine it further as an illustration of the points now under discussion. It is obvious that there is considerable ambiguity in the meaning of the familiar concept of health. We may do our best to give it objective and dependable meaning. We may define it, let us say, as the normal functioning of all the organs of the body, and proceed to endless research in physiology in the effort to determine just what such normal functioning involves. But as long as the term is used to describe an end and not merely a means or objective fact, such research cannot possibly succeed in defining its meaning exactly. We may find out, for example, precisely what physiological changes go on in the body

whèn a man smokes a cigarette of a certain brand. Some of these will doubtless be deleterious. But this does not prove that smoking is unhealthy unless we prove also that these changes are bad enough to overbalance the relaxation and other enjoyment produced by the smoke. For if we mean by health that organic condition which we want, it is clear that nothing becomes unhealthy merely in terms of the tissue-changes involved; it must also be decided whether on the whole we want those changes or not. And since our wants are not unchangeable and not always identical with those of other people, health as thus functioning remains uncertain and vacillating in meaning, without definite objective character.

Moreover, it is evident that we could not circumvent these difficulties by arbitrarily defining health in terms of the objective physiological changes, and by persuading other people to join us in using it in that sense, supposing for the moment that we might become successful in such a lexicographical campaign. We should then, to be sure, know clearly what health meant, but we should have to invent another term to denote that physiological condition which we want. For, as we saw in chapter three, every new discovery of a means involves an enlargement and reformulation of the ends to which it is relevant. In other words, every extension of exact knowledge in the form of depriving terms of their ideal vagueness and giving them objectivity of meaning, while it is a real and important extension of scientific control, helps us not a whit in the logical problem of dealing with ends—it only makes necessary the invention of a new term to take over the value-qualities surrendered by the one thus captured by science.

Precisely the same situation will be found to hold for every one of our value-concepts which in their main uses denote ends rather than means. In so far as we need to use in our thinking names for these ends, which are to be given something of their meaning anew in every act of thought in which they function, we are dealing with concepts whose vagueness and fickleness seem to be ineradicable. We cannot think without them; yet we cannot purge them of their vice except at the cost of replacing

them by others equally vicious. This is the fundamental factor which baffles us in our endeavor to establish a firm standard and an exact technique when we engage in reflection about ends.

This basic corollary now leads to subordinate ones. What are some of the special ways in which this essential vagueness of meaning of these value-concepts introduces uncertainty in our attempt to use them and make decisions about them?

**This vagueness leads to insecure deduction**

Well, in the next place, the elaboration of the bearings of our suggested modes of meeting the situation brings us into a kind of hazy complexity when we are trying to determine our end that has no parallel when the end controlling our thinking is fixed and clearly defined. In the latter situations we elaborate the bearings of suggestions only to the point where it is possible to measure them in terms of the controlling end and select the one which most nearly meets its conditions. In finding out how to get downtown most quickly, for example, we only elaborate those consequences of the different suggestions which indicate the amount of time they might be expected to consume; then we compare them in the light of this purpose and choose the one which promises to require least time. The process is simple and definite, and the answer precise and objective, because the controlling purpose is so. But in problems where the desired end has to be shaped by the thinking itself, we have to continue elaborating the consequences of the suggestions into as large a picture as we can, in order to reach a basis for choosing between them. It is, in short, our whole future life as lived in one way rather than another way, that we try to envision clearly, so that we may decide which life on the whole appeals to us most. Doubtless it would be an exaggeration to intimate that there are many occasions on which we find it impossible to decide until we have carried out the implications of suggestions on this grand and inclusive scale. Yet the more important the issue, the more do we attempt exactly this comprehensive forecast —to select intelligently one's vocation, for example, demands as thoroughgoing a portrayal as we find it possible to make. And in less important situations where we really try to decide what we want to do, we find it necessary to develop far more

extensive pictures of the consequences bound up with our suggestions than when we are quite sure just what we want. It is only when the forecast has run into this high degree of complexity that one picture is able to overbalance the other so definitely that we can say with confidence which we prefer.

Due largely to our inability to foresee everything

But it is evident that the larger and more complex these imaginative forecasts become, and the farther in the future the events which we anticipate as likely to follow from the adoption of a present suggestion, the less dependable do they become as measured by actual results. The primary reason for this is that more novel and quite unpredictable events will have an opportunity to wreak their influence on the projected outcome, the more complex and remote the consequences envisioned. Things do happen which we did not and could not prophesy. Use our present knowledge in the most careful way we may, we might as well take it for granted that many unexpected factors will enter our experience long before the picture of anticipated consequences is entirely unrolled which was the basis of our present decision, and that some of these factors, had we known that they were coming, would have had some effect on our attempt to make a choice. To return to our earlier illustration, I might decide, on the basis of the best information and clearest deductions at present possible, to take the attractive offer open to me, and yet find, after settling in my new position, that the work became much more uncongenial than I had feared and that the larger salary was not quite so prompt and dependable as my present income. These unanticipated factors might make me quite sorry that I had made the change.

It is in large part the uncertainty of these imaginative forecasts, due to our inability to know in advance everything that is going to affect the outcome of our choices, that infects with vagueness and instability the names by which we try to denote these desired consummations. If I engage in such and such activities, we say, I shall be likely to promote democracy. Now what do we mean by democracy in such an utterance? Obviously, the only thing that we can mean, concretely, is a certain range of the effects which we deduce from the activities we pro-

pose to engage upon. We may define it, if we wish, in still more abstract terms, but such a definition would remove it yet farther from its concrete meaning in terms of a definite structure of human relations, involving definite changes from our present social life. The latter meaning can only be given in imagination as we develop by it certain consequences of suggested present ways of acting. And inasmuch as our present knowledge, on which this imaginative portrayal is necessarily based, is always circumscribed by the range of our experience to date and is never complete, it is difficult to see how these anticipated consequences can be freed from the play of accidental forces, nor, accordingly, how the ideal concepts by which we describe them can be given dependable meaning.

Scientific experiment with ends im-

In the third place, when we come to the final step of the act of thought about these larger ends, we discover that anything remotely resembling experimentation of the sort that the scientist depends upon is entirely out of the question. This impossibility of experiment is due to two considerations. One is that to experiment on anything we must always be guided by a definite end; accordingly, in thinking where the nature of the desired end itself remains to be determined, how could anything in the way of a concrete experiment be performed? Or, if we wish to introduce the term experiment into problems of this sort, we may state the same point by saying that *the entire balance of our life to which we commit ourselves by the decision we make constitutes the experiment.* Nothing shorter can be appropriately regarded as such, for our decision is essentially between one way of life and another. This notwithstanding the fact, of course, that it may not take very much of the experiment to convince us that our choice was mistaken or to make us feel tolerably sure that it was correct. In other words, in problems of this kind, the verifying experiment spreads out over the future and cannot be completed by any manipulation of given materials in the present.

Another consideration adds greatly to the difficulty. In a sense we have the entire past history of the human race recorded in tradition as a guide to our choices—here is an experi-

Life itself must constitute the experiment

ment on a grand scale with most of the values and typical situations with which we have to deal in our present thinking. But the present problems are never quite identical with those faced in the past; moreover, the more intelligent we are the less satisfied we shall be with even the best answers at which past fumbling has arrived. Why not, then, devise arbitrary experiments under controlled conditions which will enable us to determine issues left ambiguous from the past and reach tolerably dependable results within a brief enough time so that the rest of us could benefit by the lessons learned? Why not, in short, colonize an island with people whom we shall compel for a time to practice the type of democracy or communism or health control or alcoholic prohibition we favor, insulating them from the disturbing influence of irrelevant factors? Because, of course, human beings are too valuable to be experimented upon in this external fashion, in their case the maxim *experimentum in corpore vile* has no application. And in general the more we advance from means toward ends, from facts toward values, the more we are dealing with things which we most deeply prize, and which we are unwilling to submit to experiment other than that involved in our own free self-commitment to a chosen destiny. Accordingly, if we respect this feeling of unlimited worth for one's own selfhood that seems to be rooted in humanity, there seems to be no way of experimenting with these values other than the slow, halting, and fitful experiment of life itself, speeded up slightly where groups of people become reflective enough to be willing to try out more freely novel schemes of social organization. And even if we could experiment in a genuine sense, it would still perplex us to know how the lesson would be apt to apply to more normal and complex conditions (unless experiments on all sorts of ideal schemes should be made at the same time), and we should still be unable to forecast what future events might occur to distort the social pattern thus sketched, and reënvelop with a hazy penumbra the meaning of the concepts thus experimentally clarified.

We thus in summary come back to the general unpredictability of the future as the fundamental source of the inherent am-

Our ends the growing-point of our experience

biguity of our value-concepts and the consequent puzzle as to how to set up dependable norms of correct thinking when we are dealing with ends rather than with means. Some things we can predict with confidence—those which follow from the fully established laws of inorganic changes and which take place on so grand a scale that other and less predictable happenings cannot distort their behavior much. But our knowledge is not all-embracing. Unanticipated events constantly break in upon our experience, and every such event forces us to modify our imaginative picture of the future and changes our preferences as between the alternative pictures which in imagination we are constantly building and comparing. Indeed, it frequently happens that such events modify our purposes for the future after we have devoted long effort to realize them and see their attainment near. A business man, for example, may have planned for years to bring his affairs to such a state that he could take his family to Florida for the winter, only to find himself promoted to a position of such challenging responsibility that he no longer wishes to leave it for a vacation at that time of the year. This is simply to say that our preferences are the growing-point of our experience; they vary more than anything else about us. Whatever other changes attract our attention involve changes in the kind of future which we picture as desirable, for every such change brings its response in the way of enjoyment or dislike, and begins to function in our imaginative portrayal of the whole panorama of life as something to be sought or shunned, comparable now in its attraction or repulsion to the joys and sorrows with which we are already familiar. This involves a continual shift in emphasis of the elements which form the core of our ideals of good, some elements derived from our past experience being shoved into subordinate places by newly experienced facts that seem much more appealing. This kaleidoscopic transformation of our imaginative picture of what we want is constantly going on, and must go on as long as our basic mental structure remains what it is and our knowledge remains incomplete. We see the process in its most interesting form in the way in which a child passes in interest from one toy

to another, as former enjoyable experiences begin to pall and newly exciting possibilities come on his horizon. But with less revolutionary changes the same process goes on in the most mature mind, and so far as we can see it infects our conceptions of ends, our notions of what we most deeply want, with a variability and elusiveness that send us wandering in total bafflement when we seek to establish clear and universal standards for thinking about these tantalizing goods.

Task of Part IV

How shall we reduce the realm of values to the beginnings of logical control? This is the form taken by the problem of the present section if we express it in terms of the guiding assumption which has been selected to unify the discussion. In carrying this assumption through the succeeding chapters it is our purpose to bring out the logical problems involved rather than to attempt to answer them. Indeed, if the considerations just adduced are correct no answer can be given that is more than very meager and unsatisfying—a challenge to still clearer thought in the future.

We turn successively in the following chapters to several different fields about which we need and try to think, but whose essential concepts elude objectivity of meaning. First we shall discuss types of problem in which the pertinence of our guiding supposition that the logical difficulty is due to their complication by indefinite values is most clear, such as ethics and law. Then we shall turn to history and metaphysics, where the assumption must struggle against more serious opposition. Finally we shall consider æsthetics and religion, where the problem of right thinking takes yet different forms. What difficulties does the relativity of our thinking to variable preferences plunge us into in these realms, and in what ways have thinkers tried to set up acceptable norms for reflection in them? Can we see any clear direction in which we ought to proceed in order to discover what solid footing is possible?

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CHAPTER FIFTEEN

# RIGHT THINKING IN ETHICS

Difficulty of limiting the field of ethics

ETHICS is a subject which it is exceedingly difficult to delimit. In its broadest sense it includes the entire realm of values, and it is very hard to conceive it consistently in any more limited way. Many writers on ethics have, of course, attempted to restrict its meaning by affirming that it relates to human conduct, in so far as the latter comes under our judgments of right or wrong. But inasmuch as values are always things in which we are interested, they stimulate conduct in the direction of their actualization or fuller possession; moreover, we realize that there is nothing to prevent actions which at present arouse no moral judgment from being pronounced right or wrong in the future, when their consequences have been more fully revealed. Accordingly, these limitations are quite tenuous and under scrutiny readily evaporate. None the less a helpful practical restriction is possible in terms of the distinction of the last chapter. Conduct embarked upon as a result of the reflective determination of ends certainly subjects itself to ethical judgments par excellence; it is pretty difficult to distinguish between saying that an imagined way of life appeals more deeply than any alternative to our entire nature and saying that it is the right way to follow, or the way that we ought to put into practice. Our very decision itself thus constitutes an ethical judgment, and it is such choices as these when performed by others which we most quickly make the objects of our moral approval or condemnation.

While it is, therefore, hard to restrict the application of the term ethics to any realm less comprehensive than the realm of value-situations at large, yet we find ourselves most directly facing problems that we call ethical when we are consciously trying

to shape ends of conduct and decide what we really want to do, in situations which seem to be completely described in these terms. Accordingly, in the present chapter we shall discuss the logical problems involved in this type of decision, leaving to the succeeding chapters those connected with the determination of ends when our thinking is complicated by other factors.

**Typical ethical situations**

Shall I take the liquor which my host proffers me? Shall I go into business or remain in teaching? Shall I allow an extra-marital attachment to develop to the point where it might break up my home? Shall I tell a lie to save a friend from repeated annoyance? Shall I constitute myself a conscientious objector in time of war? Shall I obey the speed laws of this town when the road is quite clear and no patrolman is in sight? Such questions as these press upon us now and again for decision, and we have to make the decision on the best terms we can—we cannot leave the matter without taking any alternative. And the way in which we try to decide, so far as we deal with the problem reflectively, is that outlined in the chapter just concluded. We develop in imagination the implications of the available alternatives, carrying the picture out in detail to the point where some consideration emerges capable of swinging the balance of value definitely to one side or the other. Then we say that one is the best, or right, thing to do, and are able to make our decision.

**Extent to which custom controls conduct**

Now we must note that habit and social custom control many of our decisions in value-situations so that active reflection has very little to do in shaping the resulting conduct. The problem has hardly risen to clear consciousness before it is classed under some rule that we have habitually followed, or that social tradition has enforced upon us as alone the legitimate way of meeting a situation of this sort. Without seeing at all the larger implications of the possible alternatives, we accordingly commit ourselves to action of a familiar and expected type. Moreover, deplore this fact as we may, it is yet necessary to recognize that it is quite inevitable for us to meet value-problems of the less important level in this almost unreflective fashion in order to concentrate the energy of intelligence on the problems

where the larger ends are at stake. For we have not time to think profoundly about everything.

No sharp line between dogmatic and reflective morality

But if this consideration be sound, we can draw no absolute line between two general methods of meeting ethical problems which have been strongly set apart by many thinkers, namely the method of dogmatic or customary morality and the method of genuinely reflective morality. By the former these thinkers mean the method of simply developing the implications of suggested modes of conduct to the point where the situation is seen to come under some commandment accepted as authoritative, as might be done by a salesman who, considering a moment whether what he was about to say were quite true or not, and deciding that it was not, refrains from saying it in obedience to the commandment, "Thou shalt not lie." By the latter they mean the method of picturing the consequences of each suggestion as fully as possible, so that in choosing between them we shall have in mind all that they involve and not merely their relation to some principle already accepted as final. This is illustrated by such a situation as the reflective attempt to determine one's choice of a profession. But in fact neither of these methods as thus conceived can be erected into a comprehensive principle for guidance in ethical problems. The latter is impossible because none of us has time or conscious energy enough to apply this method of complete elaboration to all the value-situations which we face; at most we can regard this as a goal to be approximated in our most critical decisions. The former is impossible because no one can say in advance what rule, previously accepted as authoritative, might not come in some future situation to seem inadequate, and the situation demand further development in order that a decision may be reached. Dogmatism is always a matter of degree, and is relative to one's point of view. It is only to reflective minds of a more alert sort that anybody seems to be controlled by merely dogmatic principles. To say that many people decide dogmatically simply means that the largest rule that many people seem to be able to reach to guide them in their decisions is one which more reflective minds have transcended, seeing much empirical evidence

to cast doubt upon its value. But no one, however reflective, can make a decision intelligently without justifying it by some principle, which for the situation in hand, at least, is regarded as of unquestioned validity. It is, accordingly, a rather doubtful procedure to brand other minds as quite dogmatic in their decisions; that we see problems where they do not and inadequacies in the rules which hold their complete confidence, does not imply that they are not reflective when occasion forces them to be, nor that we are not dogmatic when we come to apply the largest ideal that we as yet have been able to glimpse. The difference is primarily in the degree with which reflection has critically examined the ends of our conduct, infusing its own character into those that stand the test, and rendering more flexible the subordinate rules of behavior.

**All moral decisions both reflective and dogmatic**

This is to say that all of us are both reflective and dogmatic in facing problems of value. If they come home to us as live problems at all, we think our way through them till some consideration appears which determines our choice. And with the most intelligent of us, as well as the least, this determining consideration can be verbalized in the form of a statement of principle—if not the rule, Thou shalt not lie, then some such rule as, Realize thyself, or The greatest happiness of the greatest number. Likewise, with the most intelligent as well as the least, by far the larger number of our value-problems are decided by the merest modicum of intelligent elaboration, quickly fixing upon some rule well established in habit. If this were not so, we could hardly think clearly at all. We should have reached no answer to one problem by the time another urgently required decision.

**Yet systematic reflection in ethics of paramount importance**

There is thus no absolute break between those situations in which the difficulty has hardly become conscious before we apply some customary rule to it and dismiss it from our minds, and those in which we develop the consequences as far as we are able and make a decision which we can only rationalize by appealing to the most ultimate and inclusive principle in which we are able to formulate our ideal of good. None the less, there is a vast difference, and one of fundamental logical bearing, be-

tween the thinker who has made a serious effort to criticize his ethical assumptions and one who has only admitted exceptions to them here and there as forced by concrete situations, without attempting to straighten out intellectually the inconsistency involved. With reference to problems of the determination of ends, the latter is in the position that the scientist would occupy if he noticed exceptions to his accepted laws but made no effort to correct the laws in the light of the new facts and had no clear consciousness of the standards of truth and reality that he was really using. Now is it not clear that any man who supposes himself to believe that "Thou shalt not lie" is an absolute prohibition, while accepting the infractions of it which we daily commit as matters of polite courtesy or to avoid some terrible calamity (for example, the deception by which a crowded theater which has caught fire is quietly emptied), is in exactly this inconsistent and thoroughly illogical state? The former, on the other hand, has at least come to recognize the inadequacy of these traditional rules, and has made a serious and vigorous effort to connect his ethical choosing with a principle which can be affirmed consistently, which can unify all the lessons learned from his past experience of goods and ills and bring them to a clear focus on any present perplexity. But with this point we have returned to our main theme, for the attempt to discover such a single consistent principle is identical with the attempt to discover a dependable standard for reflection about ends—it aims at the conceptual formulation of that good which we conceive to include and condition every other real good that can approve itself as such to intelligent consideration —or at least this is the main form which such attempts have taken in the history of ethical theory. In short, to live intelligently means to live consistently; to live consistently means to live in the light of a unified ultimate standard of value.

**Objective standards for ethical thinking lacking**

What success have ethical theorists attained in the endeavor to establish such an ultimate guiding principle for thinking about values, for intelligent determination of ends? Success is surely conspicuous by its absence, if we mean by success something comparable to logical achievements in the field of science—

that is, the actual discovery of a standard that all competent thinkers could agree upon as universally and necessarily involved in correct thinking about ends. Diverse schools of ethical theory, offering different answers to this problem, have flourished since the beginning of systematic reflection about values, and still flourish; it would indeed take an incorrigible optimist to maintain that the thinking world is any nearer agreement on such a standard today than at any time in the past.

**Apparent reasons for this lack**

What are the causes of this continual disagreement? Doubtless, in part, the apparently ineradicable ambiguity of our conceptions of ends, leading different thinkers to use somewhat different terms for much the same meanings, but in part also irreducible differences in our ultimate valuations, in the goods which loom before our thinking are those to be most deeply prized. And amid this diversity of formulations of ethical standards it is well to remember that even if we could secure general agreement on some statement of principle, it would be quite hopeless to expect that everybody should mean the same thing by such a common set of terms; the preceding chapter shows that they have to be given meaning anew in every situation in which they function, and since these situations continually vary as between different individuals and as between different periods in the life of the same individual, it is evident that we might disagree hotly as to what is implied by a given conception while having no quarrel about the validity of the conception itself. Indeed, we see plenty of evidence that just this situation prevails in the case of certain concepts which we do accept with practical unanimity, such as justice and fairness. Almost everybody agrees on the validity of these ethical notions. But as to what they mean in any live problem of human relations—there such agreement is rarely to be discovered. Here, for example, is a milk strike of the farmers serving a large city community. Many important interests are involved, for producers, for distributors, for consumers. Just what does justice or fairness concretely mean in this case? It is apt to be far from an easy matter to decide, for the factors which have to enter into the meaning of those terms as thus applied are of baffling com-

plexity. The same situation would surely hold in the case of other ends on which as yet we do not agree so unanimously; accordingly, we may well doubt how far we should have advanced toward an exact standard even if agreement on such larger principles could be attained. It is perhaps true that agreement on a word tends to avoid certain conflicts that might otherwise arise, but if what we mean by it prove to be different in every case of importance, we are surely very remote still from the type of standard of correctness that the scientist can confidently use.

It is our duty, however, to plunge into the yet darker chaos that seems to be evidenced by disagreement even on what constitutes the most ultimate principle to apply in reflection about ends, the principle that is to pervade with its own meaning and character all lesser or more specific values. We shall not attempt to list the ultimate principles of all influential historical schools, but shall concentrate on the two principles which have had the widest effect on ethical thinking during the last century and a quarter, the Utilitarian and the Kantian.

**Standard offered by the Utilitarians**

The final principle to apply, according to the Utilitarian doctrine, is the conception of the greatest happiness of the greatest possible number of sentient creatures that are affected by our choice—such happiness is always the inclusive good, and the determination of our controlling want in any concrete case must therefore be guided by this formal principle; it is always good and right to act in the way implied by this conception. John Stuart Mill, the last of the three great champions of Utilitarianism, states its fundamental assumptions thus:

> The creed which accepts as the foundation of morals, Utility, or the Greatest Happiness Principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness. By happiness is intended pleasure, and the absence of pain; by unhappiness, pain, and the privation of pleasure. . . . Pleasure, and freedom from pain, are the only things desirable as ends, and . . . all desirable things (which are as numerous in the utilitarian as in any other scheme) are desirable either for the pleasure inherent in themselves or as means to the promotion of pleasure and the prevention of pain. . . . The happiness which forms the utilitarian standard of what is right in conduct, is not the agent's

own happiness, but that of all concerned. As between his own happiness and that of others, utilitarianism requires him to be as strictly impartial as a disinterested and benevolent spectator. . . . This, being, according to the utilitarian opinion, the end of human action, is necessarily also the standard of morality; which may accordingly be defined, the rules and precepts for human conduct, by the observance of which an existence such as has been described might be, to the greatest extent possible, secured to all mankind; and not to them only, but, so far as the nature of things admits, to the whole sentient creation.[1]

Ultimate principle of Kantian ethics

Kant's ultimate principle, on the other hand, is formulated in quite a different set of conceptions. Right becomes the basic idea in place of good, and instead of happiness interpreted in terms of pleasure, he sets up the notion of a law of duty as involved in the very rational and social nature of man. This law prescribes the absolute and unconditional acceptance of the equal value of all persons in the moral realm, and therefore states it as our supreme duty to act always in such a way as to respect this equal value, in such a way, more concretely, as we should be willing for all persons to act were they facing the same problem. As Kant expresses the principle it is a careful philosophical formulation of the underlying idea of the Golden Rule, "Act only on that maxim whereby thou canst at the same time will that it should become a universal law."[2] Accept, in other words, no special privileges for yourself, privileges which you would not be willing to have everybody enjoy. Keep your promises because you realize, when testing the temptation to break them by this principle, that you would not want to live in a world in which other people broke promises whenever they found it inconvenient to keep them; succor the unfortunate, because you would want to find help available if you should become the prey of sudden calamity; and so through other typical moral situations. If we neglect some of the highly abstract and technically formal modes with which Kant begins his discussions, the principle comes at bottom to this: Accept wholeheartedly as authoritative the democratic voice as it reveals itself in your own reason, make without reservation your

[1] J. S. Mill, *Utilitarianism* (Everyman Edition), pp. 6, 16, 11.
[2] T. K. Abbott, *Kant's Theory of Ethics*, p. 38.

own all those guiding rules of conduct that you realize you would want other people to live by in a world in which you were socially bound up with them.

**Extent of the divergence between them**

It is evident that there is much difference between these principles as answers to the problem of the standard or ultimate principle of intelligent choice. In fact, to many adherents of the Utilitarian view, Kant's doctrine has seemed like little more than a philosophical consecration of the rules already too rigorously fixed in social tradition; in some of Kant's statements and in the historical influence of his philosophy there is some justification of this judgment. On the other hand, to thinkers of the Kantian type, Utilitarianism, on account of its hedonistic foundation (its interpretation of happiness in terms of pleasure), has seemed to be destructive of all genuine morality. Carlyle dubs it a "pig philosophy," which thinks of the universe as a swine trough, and defines virtue as the attainment of the largest possible quantity of "pig's wash." With reference to the assumption that hedonism or pursuit of pleasure can become morality by substituting general happiness for that of the individual, he says its problem is that of "Given a world of knaves, to produce honesty from their united action." [1] It is clear, of course, from our discussion of the essentially ambiguous character of our fundamental ethical concepts, that with many people guidance by these diverse propositions would issue in substantially the same choices and acts. If a man's character is such that he is very sensitive to the social ramifications of his conduct, he will be apt to stress the Utilitarian insistence on the equal right of all persons to happiness and thus find it impossible to pursue the greatest happiness of the greatest number without implicitly obeying also the Kantian universal law. And if a man's intelligence is flexible and alert in each situation, so that he does not assume too readily that some traditional rule is exactly what he would want other people to follow if they were in his place, he might as a Kantian decide concretely on the same mode of action that a strict Utilitarian would select. But we could surely not count on these diverse formulas assuming the

[1] Quoted from Dewey and Tufts, *Ethics,* p. 265f.

same meaning in concrete cases, and it is safe to conclude that on the whole they would not even be so apt to do so as the same formula. They seem to reflect fundamentally diverse approaches to the problem of an ethical standard, and different conceptions of its essential nature.

Illustrated in a concrete case

Recognizing the haze thus which surrounds this whole situation from the logical standpoint, it would yet not be difficult to pick out a case of ethical conflict in which for most people these two principles would lead to a quite different envisioning of the right way out of the conflict, and accordingly furnish justification for a very different solution in each case. Suppose a cashier of a bank, while out at lunch one day, happens to sit near a table at which a director of a large corporation is discussing certain of the corporation's plans with an attorney. The director is known to him, through occasional transactions at the bank, but he is not personally known to the director. He overhears the director remark to the attorney that the corporation has changed its plans with reference to the L—— factory, and that it has decided to purchase the P—— property for the factory site if it can be secured for $1,100,000 or less, and that after an imperative business trip of five days he is going to open negotiations for the purchase. Now it happens that the owner of the P—— property is also a depositor at the cashier's bank, and the cashier knows that he is anxious to dispose of his holdings and retire from business. He thinks it likely, accordingly, that the property could be secured for something less than $1,100,000, and on rapid investigation discovers that the owner would be willing to part with it for $950,000, even this figure representing a generous profit over his original purchase price. Here is a chance for the cashier to make a tidy sum of $150,000. He quickly discovers that the deal could be handled for the few days that the title is in his hands with a sum of about $200,000, which he could take from the bank and replace without anyone else knowing anything about it. Shall he make the purchase and secure the profit of $150,000, which would be a godsend to his family and put him on easy street for the rest of his life?

Solution in terms of the Kantian assumption

If the problem were thought through in terms of the Kantian principle, with its central emphasis on the authority of universal law and whole-hearted acceptance by each moral individual of the social rules that he would prefer others to obey, the answer would probably be easy and simple. He would reason that if he were in the position of any of the other persons involved in the transaction, he would certainly not think it just for an outsider to reap a large personal profit in this way without having performed any service of value, merely because he accidentally overheard a business conversation. He would hardly suppose that it could be regarded as a universal law that such a coincidence gave a legitimate title to a vast sum of money. Moreover, if there were any remaining doubt on this point, his obligation to the bank would be sure to settle the question. He could hardly view with approval a banking world in which every cashier should be free to draw upon the bank's money in this way, however certain it might seem that the money could quickly be paid back. For something might happen to prevent its repayment, and the money is the bank's, not his.

Probable solution by the Utilitarian approach

If this cashier were a Utilitarian, however, there would be a strong probability that he would develop a different picture and reach a different conclusion. For while the Utilitarian philosophy insists upon the equal right of all human beings to happiness, it encourages an individual in a moral situation to guide his conduct in such a way that the greatest total of happiness shall be secured to the greatest number of people affected by it. On these terms it might seem tolerably clear that he ought to make the purchase. For the increase of happiness thereby promised to himself and his family would be enormous, while it would be difficult to see whose happiness would be really decreased by his action. The present owner is quite willing to sell for $950,000, and at that figure he makes a fair, if not a substantial, profit. The corporation is quite willing to pay $1,100,000, and estimates that at that price it will be able to return generous dividends to its stockholders. A higher sum for the first or a lower price for the second would make comparatively little difference to them, moreover they need know

nothing about the fact that he overheard the conversation and hence need have no harsh feelings toward him and no sense of disappointment. As for the bank, the decision of the corporation is definite, and therefore he will certainly be able to return the money borrowed; furthermore, if some hitch in the proceeding should develop he is securing the property at a low price and could surely dispose of it again at around the same figure. Accordingly, no one connected with the bank will be adversely affected by his conduct. It might easily seem, therefore, that the greatest happiness of the greatest number affected by the situation would be secured by making the deal. The happiness of his own family will be enormously increased, while that of the others involved will not anywhere be appreciably decreased. If he does not make the deal, the happiness of his family will suffer greatly, while that of the present owner and the director would only be moderately advanced. And as for the stockholders, a difference of a hundred thousand dollars or so in a single transaction would never make a discoverable difference in the enjoyment of any one of them, especially since none of them would expect any such difference.

Which is right, and why?

Which of these answers would be right? And if we are tolerably sure in our own minds which is right, how can we state objectively the standard which we feel should apply here, and how straighten out the logical difficulties involved in the disagreements of reflective people on such matters? Almost all of us would doubtless condemn a cashier who should take advantage of such an opportunity in this way, yet if we were in his place and counted ourselves adherents of a generally Utilitarian position, we should not find it difficult to work out a complete justification for succumbing to the temptation. This emphasizes the tremendous practical need of securing more objective norms for the guidance of our thinking about ends; ambiguity and uncertainty about our concepts of ultimate value necessarily leave a gap between the basis on which we judge others and that which we can rationalize as a legitimate foundation for our own action. Whether our spontaneous judgment of others is too severe, or our judgment of ourselves too biased,

or both, at least the establishment of more definite and universally compelling standards would further practical consistency and confidence in our choices. For an earnest man cannot view the consequences of his conduct lightly.

The problem of reflective statesmanship

In issues involving the relations of larger groups of people, such as corporations, societies, cities, nations, this difficulty of the reflective thinker usually takes a more specific form. This form is conditioned by the fact that many people belonging to his own group, as well as many members of the one with which the conflict has arisen, are of closely circumscribed sympathies, and find it impossible really to appreciate what measure of justice supports the claims of the other side. The immediate interest of the group seems clear; genuinely constructive thinking in the effort to reach a fair adjustment tends, therefore, quickly to evaporate in favor of the appeal to force to establish the group interest without further parley. This is, of course, revealed in a particularly threatening form in the difficulties that arise between nations. Let us consider, for example, the notion of self-defense. Self-defense against external attack is regarded as morally right by all except extreme pacifists—but where does self-defense begin? And who shall draw the line between self-defense and aggression? Is a nation going beyond the requirements of self-defense which maintains a standing army? A system of modern forts along every frontier, and of railroads for use in rapid mobilization? A navy sufficient to protect its coast? A navy sufficient to meet that of any two powers? Is it self-defense to strike first when you see your neighbors preparing for war, in order that the war may be fought on their territory rather than yours? And when possible causes of conflict arise, shall we be ready to arbitrate everything in order to preserve peace, or are there certain issues on which we shall insist that our own conception of justice is final, and we shall neither submit to our opponents without a trial of force, nor yield right of judgment about it to a disinterested tribunal? The tendency of most people is to make decided reservations on this point, if not in theory, at least in practice, when issues deeply stirring greed and passion appear on the

horizon. The reflective thinker's attempt to deal clearly with the values at stake is, therefore, greatly perplexed by the fact that he is caught in the maelstrom of social fears and prejudices, and has to allow in his thinking for the inevitable influence of these irrationalities. What standards ought the wise statesman to follow in dealing with such complex and baffling situations? What ends are in the direction of genuine social advance and yet near enough to the horizon of his more impulsive neighbors, so that the largest attainable measure of social good can be secured?

Illustrated by the Mexican controversy

As illustrative of many of these difficulties we may consider the international problem arising recently between the United States and Mexico, due to the attempt of the latter country to put seriously into effect certain provisions of the Mexican constitution of 1917, relative to land ownership. This constitution nationalized all subsoil deposits, such as petroleum pools, etc., which had previously been understood to be the property of the surface owners, and accordingly substituted for the unlimited right to exploit such deposits leases extending up to ten years for corporations and not more than fifty years for individual owners. The constitution provided also that all foreigners holding such leases must renounce appeal to their own governments in any dispute arising concerning their rights, and must place themselves unreservedly under the control of Mexican law and courts. The matter came to a head late in December, 1926, as registration with the designated Mexican officials had to be made by the 1st of January in order to secure certain privileges appertaining to those who had acquired their titles prior to 1917, and American oil magnates appealed to Washington to know what support could be counted on from the American government in resisting compliance with these requirements. What should the United States government do in this situation? Should it follow the procedure provided in the Treaty of Guadalupe-Hidalgo, signed in 1848, agreeing to the method of amicable adjustment of disputes arising between citizens of the two countries, and implied by the fact that both nations were signatories to the Hague Convention? This would involve expressing

its readiness to arbitrate the points under dispute. Or should it pronounce the new constitution as in effect confiscatory of American property without compensation, and insist that legally acquired titles under the earlier constitution must be protected if necessary by American arms? Since over a billion and a third of American dollars were invested in enterprises in Mexico, strong pressure was brought to bear on the government to pursue at once the second course.

Shall the issue be arbitrated or not?

A decided difference of opinion soon made itself felt throughout the United States as to which of these alternatives ought to be adopted. Many organizations of the most varied types passed resolutions favoring arbitration, including the Administrative Committee of the Federal Council of Churches of Christ and the American Federation of Labor. The arguments for this point of view were perhaps best set forth in a statement by a committee of one hundred and one professors occupying chairs in forty-three universities and colleges in America, made public on January 23, 1927. The statement declared in part:

> We, the undersigned, believe that the United States Government should resort to arbitration to settle the dispute with the Mexican Government over the effect of the recent oil and land laws of Mexico on the property rights of American citizens. This dispute threatens the friendly relations which should continue to exist between the two neighboring peoples. President Calles has already stated unofficially that Mexico is willing to submit certain aspects of the Mexican-American controversy over the alien land and oil laws to the Permanent Court of Arbitration at the Hague. Such a course would be clearly in accord with the Treaty of Guadalupe-Hidalgo and of the Convention of the Hague. It is compatible with the nature of the difference, since at the root of the difficulty lies a clearly justiciable question—that of the infringement of the property rights of American citizens by the application of the Mexican land and oil laws.
>
> The United States has ever been foremost in urging upon other nations the peaceful settlement of justiciable disputes between Governments; nor has our Government failed to put the principle into practice. We have a long record of threatening disputes settled by the justiciable methods. The arbitrations under the Jay treaty with Great Britain began a new era in the history of progress of mankind toward peace through justice, in which our country has been a leader. "We have been the apostle of arbitration. We have been urging it upon the other civilized nations. Presidents, Secretaries of State, Ambassadors, and Ministers—aye, Congresses, the Senate and the

House, all branches of our Government, have committed the United States to the principle of arbitration irrevocably, unequivocally, and we have urged it in season and out of season on the rest of mankind." (Quoted from address of Elihu Root on Panama Canal Tolls, in Senate, January 21, 1913.)

The statement then cites the provisions of the Treaty of Guadalupe-Hidalgo, and notes that both nations are signatories to the Hague Convention for the pacific settlement of international disputes. The document then continues:

The two countries have in the past applied both the principles of the treaty of Guadalupe-Hidalgo and of the Hague Convention to disputes arising between them. It was on the motion of President Roosevelt that the United States and Mexican Governments brought before the newly created Permanent Court of International Arbitration its first case, the differences which had arisen in respect to the Pius Fund of the Californias.

Then the United States Government strikingly affirmed to a doubting world its continued confidence in the judicial settlement of disputes between nations and maintained the leadership in the formation of a world organized for peace rather than for war. At the present time an international tribunal under the convention of September 8, 1923, is functioning, before which certain claims of citizens of each country against the other are being determined.

If the property rights of American citizens are being impaired by the application of the new oil and land laws of Mexico, and if their claims are included in the convention in force, then the United States has already agreed upon a method by which they should be adjudicated. If not, then the precedents of nearly a century of peaceful intercourse with our Spanish-American neighbors should be followed and either the machinery provided by the Permanent Court of Arbitration at the Hague be used, as it was in the Pius Fund case, or a special arbitration tribunal set up.

The questions at issue are appropriate for settlement by the judicial method. Protracted delay is dangerous. The property questions which are at the base of the differences may become obscured; the issue may become one of national pride and sentiment; feeling may be aroused which will make impossible the judicial settlement now practicable.

Two days later, on January 25, 1927, the United States Senate passed unanimously a resolution favoring arbitration of the Mexican issue, provided that no change in the status of the property of American citizens in Mexico take place pending the final award. The text of the resolution was as follows:

Resolved by the Senate of the United States, that while by virtue of sovereignty the duty devolves upon this government to protect the lives

and property of its nationals in foreign countries, which duty is not to be neglected or disregarded, it is nevertheless sound policy, consistent with the honor and best interest of the United States and promotive of international peace and good will, to submit to an arbitration tribunal, which shall apply the principles of international law, the controversies with Mexico relating to the alleged confiscation or impairment of the property of American citizens and corporations in Mexico, the arbitration agreement to provide for protection of all American property rights pending the final outcome of the arbitration.

That in good will and friendliness efforts should be made and persisted in to effect arrangements which will commit the two governments to the policy of abiding by and executing awards that may be made in consequence of such arrangements to arbitrate.

President Coolidge, on the other hand, supported by many organizations and particularly by business interests concerned for the protection of American property abroad, adopted the view that the right of the matter was so clearly on the side of American property-owners that it would be silly if not dangerous to submit legally acquired titles to arbitration. This point of view is well represented by an editorial in the *Chicago Tribune*, appearing just before the Senate resolution above was voted upon. The editorial in question is as follows:

WHAT IS THERE TO ARBITRATE IN MEXICO?

Senator Robinson has offered a resolution declaring it to be the sense of the senate that the points in controversy with Mexico be submitted to arbitration. Secretary Kellogg, in comment, said that he had been giving careful consideration to the question of applying the principle of arbitration in this case.

The issue with Mexico is almost exclusively one of property. It is not a boundary dispute, one of fishing rights, of conflict in extraterritorial regions, in trading privileges, compensation for damages, or any other of the many questions which frequently are in international controversy and frequently are submitted to arbitration. The difficulty with Mexico concerns property legally acquired under Mexican law by foreign investors. The titles are Mexican titles and at the time they were acquired the investors were welcome.

Their development of the land sold them, principally in oil, was of benefit to people generally. Mexico never has had the capital to develop resources and has been glad to have American and British capital used, partly for the benefit of the government which obtained a revenue from it and partly for the benefit of Mexicans who would be employed in the industries.

In a better organized nation, one with money, with commercial and indus-

trial power, these resources would have been developed by citizens of the country just as they have been in the United States. Mexico was unable to do this and the next best thing for the country was to bring in outside capital and industry. Mexican law permitted it and not only oil developers went in but farmers and workers. They bought arable and grazing lands. There were Americans, some British, and some of other nationalities. The best known case was that of Mrs. Rosalie Evans, the American wife of a British subject, who bought a ranch. She was killed, after her husband's death, defending her property against Mexican agrarians who fought her for several years trying to take it away from her by force.

Her story is dramatic because it was that of a brave woman fighting for her ranch and her life. It was a British case, but Great Britain could not act freely because the United States regards alien intervention in Mexico as unfriendly. In effect, British and American diplomats polished their nails while the Mexican government allowed this woman to be shot, she being several years in apparent jeopardy.

In 1917 Mexico adopted a constitution which prohibits such alien ownership of land. That has not been protested. It is the right of the country. It is a right exercised here. What is protested is the confiscation of property acquired under Mexican law before the new constitution was effective. Mexico under Obregon conceded the injustice of such a procedure and agreed with the United States that the new law should not be retroactive. Upon that agreement the United States gave the Obregon government the recognition it badly needed. In two ways, thus, the American position is bulwarked. It is based on Mexican law. It is based on international agreement.

Does Calles propose to repudiate the latter and ignore the former? There isn't anything vital in dispute except that, and consequently there is nothing but expediency in arbitration. Arbitration assumes that there is justice or equity in dispute or else it despairs of either and assumes that some workable compromise can be found which will not be really satisfactory all around, but which will be accepted.

Other nations, Great Britain particularly, expect the United States to iron out this thing and to protect alien property rights. The United States is not threatening Mexico with war. It asks Mexico to make good on its word, to abide by the acts of its own government, and to conform to principles necessary for the continuance of civilization.

The insistence upon rights is not dangerous. The surrender of them would be. The United States never will get along with Mexico if it concedes that Mexico may break laws and break treaties and take away the rights of American citizens every time there is a new administration or a new political or social policy. American citizens who are hysterical now in fear of war may reflect that an American backdown will rattle sabers more noisily and more threateningly than anything else this government could do.

Which answer is right, and why?

Which of these views is in the right? And if we are quite sure in our own convictions which is right, how shall we state the principle involved in our decision in such a way as to reveal clearly the standard which it contains? How put it in objective form, so that its validity will become apparent to others in the same convincing way in which it appears to ourselves? The fact that people disagree hotly on any important conflict between the interests of groups, such as this conflict represents, and accept no universal standard for the determination of ends, is obvious witness to the complete lack in such thinking of the logical norms that have been so successfully established in the realm of objective fact.

Suggested standard—the right answer that which gives further reflection its largest opportunity

It is our business in the present section to present challenging logical problems, not answers to them, yet a further word on such issues as have just been debated may not be inappropriate. Since our fundamental assumption throughout has been that clear thinking is more likely to reach a sound result on any subject of perplexity than anything other than clear thinking, we should seem to be justified in holding that in dealing with values as well as with facts, that type of thinking is more apt to be correct which is performed under conditions that permit clarity, thoroughness, and impartiality, than any type which rejects such conditions. Approaching the above issue in the light of this consideration, we note that the point of view that opposes arbitration tends to reject these conditions in certain specific ways. It is prepared to call a halt to further consideration of the various interests involved in the conflict, and the consequences of different modes of action, and, in place of further reasoning, to insist peremptorily that its own conception of what is right shall be accepted by all parties or else will be enforced by arms. Now, as we have seen earlier, this attitude can be justified as logically sound only in the case of relatively unimportant issues and ones which do not seriously affect the interests of others. In such situations it is valid procedure to allow some habitual rule or customary interest to dictate a way out of the difficulty as soon as possible and set active reflection free to deal with the more serious and socially conflicting problems. But in an

international issue of this kind thus to permit personal interests to assert themselves without complete reflective control, to obscure the need of full realization of all the factors that are bound up in the situation, to blind us in our thinking to the impossibility of being genuinely impartial where our own valuable interest is at stake, can hardly be justified as logical from any point of view. All this, at least, is recognized by the thinking that commits itself to the policy of arbitration. It insists on checking the natural tendency to assert our own interest unconditionally on pain of the application of armed force, and on raising such questions as these before the question is settled: Are we legally and morally committed by treaty or convention to the method of arbitration in such matters? Even if we were not so committed, would that be the method which in the long run would tend to develop the kind of relation which we really want to develop with Latin-America and with the rest of the world generally? Moreover, seeing that we are interested parties in this conflict, would it not be more likely that a tribunal having no direct interest in the situation could consider the alternative courses in a more dispassionate and open-minded manner than either ourselves or our opponents, and thus reach an adjustment that would be fair to both sides and have promise of permanence? Is it not because experience has taught us this lesson that our entire legislative and judicial structure has been slowly set up? If our contention in the conflict is right (and that it should seem to be so to us is entirely natural), then a disinterested tribunal will be reasonably sure to give us the award; if it is not right, then it will be far better for some other settlement to be made than for us to sow seeds of animosity and future conflict by insisting ruthlessly on the enforcement of our own interest, right or wrong. Few values, in other words, are so valuable that peace and good will can be appropriately sacrificed for them, for the reason fundamentally that there is no condition more essential to the fruitful functioning of intelligent thinking on all the social problems that from time to time arise, than a condition of peace and mutual confidence between the social groups involved, and no condition, on the other hand,

more impossible for the vigorous play of clear thought than the condition of hatred, distrust, and war.

Even if accepted such a standard lacks the objectivity of science

Such considerations are fairly compelling when we control our passions and prejudices sufficiently to see them clearly. If, then, we are right in holding to the general principle that correct thinking about values, as elsewhere, must approve and follow that method whereby the conditions favoring further thinking are strengthened rather than weakened—in short, that *correct thinking is itself always more valuable than any other value at stake, as being the most dependable way of realizing further values*—then we have a general standard for the reflective determination of ends more directly justifiable by logic than either the Utilitarian or the Kantian standard, and one able to give fairly definite guidance in many of the more pressing social problems. And this would mark the beginning of the achievement of a logical standard in reflection about ends.

But even if we agree upon this beginning we must not deceive ourselves into exaggerating the scope of such an achievement. Men agree that justice should always be done, too. What it means in any concrete case to exalt intelligence as the supreme value to be furthered by our decision, will still be hotly debated where eager emotions and strong biases play their rôle in men's minds, and accordingly it remains an enormous challenge to reflective thinkers of the future to devise some technique, if possible, whereby such clear light as is possible will be made to shine through the darkness in which we are wandering when we try to determine objectively the ends of our conduct.

EXERCISE.—What can be said for each of the contrasted pieces of reasoning in the following pairs, and how should the issue between them be decided?

A. (1) I have a distasteful task to do. I shall therefore postpone it as long as possible, for if I do so something may happen to make it unnecessary for me to do it at all.

(2) I have a distasteful task to do. I shall therefore do it as soon as possible, so as to have it off my mind and free my attention for things in which I am more interested.

B. (1) This is an unjust law. I therefore ought to do everything I can to make it ineffective.

(2) This is an unjust law. But I ought to obey it till it is removed from the statute-books, for it is more important to preserve law and order than to have every right of individuals respected.

C. (1) "I should worry, I should care,
I shall marry a millionaire;
If he should die, I should cry;
I'd go marry another guy."

(2) "Love is for aye.
Though the unrolled whole of life
Be void of thy warmth,
I shall not turn to another's arms.
Thou shalt be mine unmixed."

D. (1) Since reflection on ethical problems leads different people to different conclusions, I had better hold fast to the principles that I have been taught.

(2) Since reflection on ethical problems leads different people to different conclusions I can be sure that all of their conclusions are at least more intelligent than the beliefs with which they began.

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## CHAPTER SIXTEEN

# THE ROLE OF VALUE IN LEGAL THINKING

**Traditional view of judicial thinking**

AT FIRST sight it might seem that these confusing ambiguities of our value-concepts could play no necessary part in the thinking of a judge, set up as he is to interpret a body of law which has usually been stated already in as clear a fashion as competent legal minds can state it, and whose meaning has already been clarified by previous decisions which now operate as guiding precedents for its further interpretation. Accordingly, the thinking of the judge has been traditionally conceived after the fashion of a train of clear and systematic syllogistic reasoning. The major premises for any given piece of thinking are formed by the pertinent laws previously established by legislatures or constitutional assemblies, or in some cases the common law; the minor premises are furnished by the statement in legal terms of the acts about which the question of legality is raised. With the wealth of interpretative data furnished by the precedents built up in the course of the entire history of law, what should prevent the judge from deducing his conclusion with complete confidence that it is the only valid one which the premises could possibly allow? The acts in force prescribe such and such a penalty for manslaughter; this man is guilty of manslaughter; therefore he must undergo the penalty prescribed. In occasional cases where the evidence is unequivocal and the definition of the act in question clear, it is indeed possible to deduce conclusions in this way without any serious doubt of their validity.

But in a large number of cases this logical simplicity quite vanishes, and the thinking of the judge can hardly be reduced to such an elementary form. And it is our guiding assumption

that the factors which thus enter to perplex the situation are almost all of them due to the fact that the concepts with which legal thinking is forced to deal cannot be rid of a fundamental element of valuation—they do not denote groups of objective facts merely, but facts valued in a certain way.

**Legal concepts appear to be value-concepts**

This becomes strongly suggested when we embark on a careful examination of the attempt of lawyers, juries, and judges to classify properly a committed act in the light of the presented evidence. Why do juries so frequently bring in a verdict of manslaughter when the objective facts as developed in the trial would just as easily, if not more easily, have justified a verdict of murder? Is it not because they are convinced that there are certain mitigating circumstances present, not specifically recognized in the laws governing the case, which make the penalty for murder more severe than would be equitable in view of the whole situation? Suppose we say to the jurors: "But it is not your business to revise the law; your sole duty is to determine just what law was actually violated in this case and to see that it is properly applied. If the facts are such as, according to the law, are describable as murder, then it is your business to apply that concept to them, not to refuse to do so because you do not think that the guilty person ought to suffer the prescribed penalty." But if the jurors have philosophized somewhat about their responsibility, they will have a ready answer to this plea. "In establishing the law about murder and manslaughter its creators were not simply describing certain facts, but were attempting to secure certain social values, and they framed their definitions in such a way that in the typical cases which they had in mind these social values would be secured by closely following the letter of the law. But they did not anticipate a case involving these peculiar circumstances, and we see clearly that to apply here what might be construed as the letter of the law would conflict rather than harmonize with the larger values that the authors of the law were most concerned to attain when they established it. Thus the deeper purpose of the law is fulfilled by calling this manslaughter rather than murder." In short, murder and manslaughter, and all the

other important legal terms, are value-concepts and not merely fact-concepts, and are liable to all the uncertainties and ambiguities in our reasonings about them that seem to be incorrigibly involved in expressions of value. To apply any such concept to a given event is to engage in a process of evaluation about the latter, and not merely to describe it in a scientifically objective way.

**Why legal evaluation is inevitable**

How can we extricate ourselves from such difficulties in our legal judgments? Shall we do away with our fundamental law, and allow judges and juries to decide *de novo,* on their own direct sense of justice, what ought to be done in each case as it arises? The difficulty with such a method would be that the dependability of a regular system of law would be lost; nobody would know where he stood in reference to the social judgment on his conduct; moreover, those assigned the responsibility of passing judgment on asserted violations of right would lack the guidance that a conceptual expression of the developed sense of the community on such matters would furnish. This method would clearly increase rather than decrease the uncertainty and variability of our reflection on these situations; we cannot move in the direction of a stable standard by surrendering what elements of standard the history of law has slowly built up.

Why not, then, define what we want to mean by these legal terms so fully and rigorously that nobody will ever have any doubt which of them ought to be applied to any given set of facts? This, however, is exactly the problem that we do not know how to solve in dealing with valuation generally. Everything would be rosy in these baffling matters if we could anticipate all events that might possibly happen, so that no novelty could ever in the future break in upon us; determine, therefore, once for all, our comparative evaluations of events; thrash out a social agreement on such evaluations; and then define to the last detail our descriptive vocabulary. In that case it would doubtless be possible to work out a system of law so precisely and completely formulated that dealing with future cases would reduce to the simplest type of syllogistic thinking. But in a world in which changes are constantly taking place in our ex-

ternal environment and in our physiological and psychological equipment that we do not know how to predict, and in which the experience and consequently the knowledge of every individual is constantly enlarging and never complete, how is such an enticing situation to be brought about? The answer, if it be a real answer, would be the answer to our entire problem of establishing standards of evaluation, for it would mean that we should have reached a situation in which all our ends are completely determined, and no longer need reflective consideration nor the requisite constant transformation of meaning when we try to find out just what we want. But as long as we are in the situation of not always knowing just what we want, we need the best guidance that is available for such reflective determination, not intimations of what our state would be if we lived in a different kind of world.

**Illustrated by a case in constitutional law**

The same problem is revealed in all branches of legal thinking; one of its most interesting, because nationally challenging, forms is the one which it takes in questions of constitutional law. We shall present for more detailed illustration of the nature of the logical difficulty a recent decision of the United States Supreme Court.

During the early years of the present century the problem of the regulation of child labor in the United States became increasingly insistent. All of the forty-eight states had passed, or were about to pass, laws regulating the age, hours of employment, and other conditions affecting the welfare of their children engaged in gainful occupations. But there was very great variation in these laws as between the different states. With respect to age, some permitted children of twelve years or younger to work for wages; some had raised the age limit to sixteen. Some permitted night work; others forbade it. In some states children could work eleven hours a day or longer; in others eight hours was the definite limit. And in many of the states with laxer laws those that did exist were rather poorly enforced. Now in their efforts to improve child labor conditions, reformers discovered a strong economic factor working against every attempt to pass more stringent laws in the states

that lacked them, and to maintain and enforce the laws in the states that had seriously tried to establish a humane standard. This was the fact that products of industries in states strictly regulating child labor could not be put on the market profitably in competition with similar products in states where cheap child labor could be used to the full, and there was a strong tendency, therefore, for industries in states with humane laws to be forced out of business in competition even for their local markets—they were overwhelmed with cheaper products imported from neighboring states where the laws were laxer and where larger numbers could be employed for the merest pittance of a wage. Now while the United States Constitution permits the states individually to control their own conditions of employment,[1] it assigns to the federal Congress power to control the conditions of interstate commerce, as indeed since the authority of a given state ceases at its border it could hardly avoid doing. In view of the obviously serious difficulty in the way of passing a child-labor amendment to the Constitution, and in view of the fact that the fundamental economic barrier to the progressive establishment of a high standard of child-labor regulation would be broken down if states with strict laws could be saved from an inflow of cheap products of comparatively unregulated child labor, champions of reform thought that the goal might be adequately accomplished by passing a federal law prohibiting the privilege of circulating in interstate commerce to products of factories where children were permitted to work under lax conditions. This power of the federal Congress had already been invoked to control the transportation of liquor, noxious drugs, and women engaged in prostitution, and as thus exercised it had been upheld by the courts. Accordingly, on September 1, 1916, the United States Congress passed an act whose main provision was as follows:

That no producer, manufacturer, or dealer shall ship or deliver for shipment in interstate or foreign commerce any article or commodity the product of any mine or quarry, situated in the United States, in which within thirty days prior to the time of the removal of such product therefrom children

[1] In the Tenth Amendment.

under the age of sixteen years have been employed or permitted to work, or any article or commodity the product of any mill, cannery, workshop, factory, or manufacturing establishment, situated in the United States, in which within thirty days prior to the removal of such product therefrom children under the age of fourteen years have been employed or permitted to work, or children between the ages of fourteen years and sixteen years, have been employed or permitted to work more than eight hours in any day, or more than six days in any week, or after the hour of seven o'clock postmeridian, or before the hour of six o'clock antemeridian.

Opinion of the majority of the court

A father of two minor sons, one under fourteen years of age and the other between fourteen and sixteen, filed a bill in the United States District Court for the Western District of North Carolina, to enjoin the enforcement of this act. His sons were employees in a cotton mill. The United States Attorney for this district was a Mr. Hammer, who, after the District Court held the act unconstitutional and entered a decree enjoining its enforcement, appealed to the Supreme Court of the United States, where the question was finally decided on June 3, 1918 (*Hammer* v. *Dagenhart*, 247 U. S. 251). Of the nine justices of the Supreme Court, five held the act unconstitutional, while four believed it to be within the constitutional powers of Congress. Since the court decides by a majority opinion, the act was thus officially pronounced unconstitutional, and the efforts of the champions of a uniform standard for the regulation of child labor throughout the United States were made of no avail. Interestingly enough, both the majority and minority opinions of the court appealed in the main to the same precedents set by previous decisions, but offered opposite interpretations of their significance as bearing on the present case. Let us examine the main lines of argument which appealed as valid to these two groups of justices.

The argument of the majority, delivered by Mr. Justice Day, after introductory preliminaries, was presented in the following words:

The attack upon the act rests upon three propositions: First: It is not a regulation of interstate and foreign commerce; Second: It contravenes the Tenth Amendment to the Constitution; Third: It conflicts with the Fifth Amendment to the Constitution.

The controlling question for decision is: Is it within the authority of Congress in regulating commerce among the States to prohibit the transportation in interstate commerce of manufactured goods, the product of a factory in which, within thirty days prior to their removal therefrom, children under the age of fourteen have been employed or permitted to work, or children between the ages of fourteen and sixteen years have been employed or permitted to work more than eight hours in any day, or more than six days in any week, or after the hour of seven o'clock P.M., or before the hour of six o'clock A.M.?

The power essential to the passage of this act, the Government contends, is found in the commerce clause of the Constitution, which authorizes Congress to regulate commerce with foreign nations and among the states.

In *Gibbons* v. *Ogden*, 9 Wheat. 1, Chief Justice Marshall speaking for this court, and defining the nature and extent of the commerce power, said, "It is the power to regulate; that is, to prescribe the rule by which commerce is to be governed." In other words, the power is one to control the means by which commerce is carried on, which is directly the contrary of the assumed right to forbid commerce from moving and thus destroy it as to particular commodities. But it is insisted that adjudged cases in this court establish the doctrine that the power to regulate given to Congress incidentally includes the authority to prohibit the movement of ordinary commodities and therefore that the subject is not open for discussion. The cases demonstrate the contrary. They rest upon the character of the particular subjects dealt with, and the fact that the scope of governmental authority, state or national, possessed over them is such that the authority to prohibit is as to them but the exertion of the power to regulate.

The first of these cases is *Champion* v. *Ames*, 188 U. S. 321, the so-called *Lottery Case*, in which it was held that Congress might pass a law having the effect to keep the channels of commerce free from use in the transportation of tickets used in the promotion of lottery schemes. In *Hipolite Egg Co.* v. *United States*, 220 U. S. 45, this court sustained the power of Congress to pass the Pure Food and Drug Act, which prohibited the introduction into the States by means of interstate commerce of impure foods and drugs. In *Hoke* v. *United States*, 227 U. S. 308, this court sustained the constitutionality of the so-called White Slave Traffic Act, whereby the transportation of a woman in interstate commerce for the purpose of prostitution is forbidden. In that case we said, having reference to the authority of Congress, under the regulatory power, to protect the channels of interstate commerce:

"If the facility of interstate transportation can be taken away from the demoralization of lotteries, the debasement of obscene literature, the contagion of diseased cattle or persons, the impurity of foods and drugs, the like facility can be taken away from the systematic enticement to and the

enslavement in prostitution and debauchery of women, and, more insistently, of girls."

In *Caminetti* v. *United States*, 242 U. S. 70, we held that Congress might prohibit the transportation of women in interstate commerce for the purposes of debauchery and kindred purposes. In *Clark Distilling Co.* v. *Western Maryland Ry. Co.*, 242 U. S. 311, the power of Congress over the transportation of intoxicating liquors was sustained. In the course of the opinion it was said:

"The power conferred is to regulate, and the very terms of the grant would seem to repel the contention that only prohibition of movement in interstate commerce was embraced. And the cogency of this is manifest, since if the doctrine were applied to those manifold and important subjects of interstate commerce as to which Congress from the beginning has regulated, not prohibited, the existence of government under the Constitution would be no longer possible."

And, concluding the discussion which sustained the authority of the Government to prohibit the transportation of liquor in interstate commerce, the court said: ". . . the exceptional nature of the subject here regulated is the basis upon which the exceptional power exerted must rest, and affords no ground for any fear that such power may be constitutionally extended to things which it may not, consistently with the guaranties of the Constitution, embrace."

In each of these instances the use of interstate transportation was necessary to the accomplishment of harmful results. In other words, although the power over interstate transportation was to regulate, that could only be accomplished by prohibiting the use of the facilities of interstate commerce to effect the evil intended.

This element is wanting in the present case. The thing intended to be accomplished by this statute is the denial of the facilities of interstate commerce to those manufacturers in the States who employ children within the prohibited ages. The act in its effect does not regulate transportation among the States, but aims to standardize the ages at which children may be employed in mining and manufacturing within the States. The goods shipped are of themselves harmless. The act permits them to be freely shipped after thirty days from the time of their removal from the factory. When offered for shipment, and before transportation begins, the labor of their production is over, and the mere fact that they were intended for interstate commerce transportation does not make their production subject to federal control under the commerce power. . . .

Over interstate transportation, or its incidents, the regulatory power of Congress is ample, but the production of articles, intended for interstate commerce, is a matter of local regulation. . . . If it were otherwise, all manufacture intended for interstate shipment would be brought under federal control to the practical exclusion of the authority of the States, a

result certainly not contemplated by the framers of the Constitution when they vested in Congress the authority to regulate commerce among the States. *Kidd* v. *Pearson*, 128 U. S. 1, 21.

It is further contended that the authority of Congress may be exerted to control interstate commerce in the shipment of child-made goods because of the effect of the circulation of such goods in other States where the evil of this class of labor has been recognized by local legislation, and the right to thus employ child labor has been more rigorously restrained than in the State of production. In other words, that the unfair competition thus engendered may be controlled by closing the channels of interstate commerce to manufacturers in those States where the local laws do not meet what Congress deems to be the more just standard of other States.

There is no power vested in Congress to require the States to exercise their police power so as to prevent possible unfair competition. Many causes may coöperate to give one State, by reason of local laws or conditions, an economic advantage over others. The Commerce Clause was not intended to give to Congress a general authority to equalize such conditions. In some of the States laws have been passed fixing minimum wages for women; in others the local law regulates the hours of labor of women in various employments. Business done in such States may be at an economic disadvantage when compared with States which have no such regulations; surely, this fact does not give Congress the power to deny transportation in interstate commerce to those who carry on business where the hours of labor and the rate of compensation for women have not been fixed by a standard in use in other States and approved by Congress.

The grant of power to Congress over the subject of interstate commerce was to enable it to regulate such commerce, and not to give it authority to control the States in their exercise of the police power over local trade and manufacture.

The Tenth Amendment to the Constitution is then cited, together with several precedents establishing the right of the states to control through the exercise of their police power conditions of manufacture and trade within the state. The argument then summarizes the fundamental assumptions upon which the decision is based:

That there should be limitations upon the right to employ children in mines and factories in the interest of their own and the public welfare, all will admit. That such employment is generally deemed to require regulation is shown by the fact that the brief of counsel states that every State in the Union has a law upon the subject, limiting the right to thus employ children. . . .

It may be desirable that such laws be uniform, but our Federal Government is one of enumerated powers; "this principle," declared Chief Justice

Marshall in *McCulloch* v. *Maryland*, 4 Wheat. 316, "is universally admitted."

A statute must be judged by its natural and reasonable effect. *Collins* v. *New Hampshire*, 171 U. S. 30, 33, 34. The control by Congress over interstate commerce cannot authorize the exercise of authority not entrusted to it by the Constitution. *Pipe Line Cases*, 234 U. S. 548, 560. The maintainance of the authority of the States over matters purely local is as essential to the preservation of our institutions as is the conservation of the supremacy of the federal power in all matters entrusted to the Nation by the Federal Constitution.

In interpreting the Constitution it must never be forgotten that the Nation is made up of States to which are entrusted the powers of local government. And to them and to the people the powers not expressly delegated to the National Government are reserved. *Lane County* v. *Oregon*, 7 Wall. 71, 76. [Further precedents are added.] To sustain this statute would not be in our judgment a recognition of the lawful exertion of congressional authority over interstate commerce, but would sanction an invasion by the federal power of the control of a matter purely local in its character, and over which no authority has been delegated to Congress in conferring the power to regulate commerce among the States. . . .

In our view the necessary effect of this act is, by means of a prohibition against the movement in interstate commerce of ordinary commercial commodities, to regulate the hours of labor of children in factories and mines within the States, a purely state authority. Thus the act in a twofold sense is repugnant to the Constitution. It not only transcends the authority delegated to Congress over commerce but also exerts a power as to a purely local matter to which the federal authority does not extend. The far-reaching result of upholding the act cannot be more plainly indicated than by pointing out that if Congress can thus regulate matters entrusted to local authority by prohibition of the movement of commodities in interstate commerce, all freedom of commerce will be at an end, and the power of the States over local matters may be eliminated, and thus our system of government be practically destroyed.

For these reasons we hold that this law exceeds the constitutional authority of Congress. It follows that the decree of the District Court must be affirmed.

Summary of the argument

We may abbreviate the essential steps in this argument as follows: The Commerce Clause of the Constitution gives Congress power to regulate commerce among the states. Such regulation has been held by the courts to extend to complete prohibition only when the articles exported are in themselves harmful and where the use of interstate transportation is necessary

to the accomplishment of harmful results. In the present case this element is obviously lacking. Moreover, in this case it is not really commerce that is prohibited; it is certain methods of producing articles before commerce in them, properly speaking, has begun. But it is contended that Congress may exercise its authority under this clause to prevent unfair competition through interstate commerce in states with rigorous child labor laws. Yet the Commerce Clause was clearly not intended to give Congress a general power to equalize economic advantages among the states, which advantages depend on the most various factors, many of which nobody would think Congress had any constitutional authority to tamper with. Since, therefore, the real intent and natural effect of this act is to invade the field of local regulation of trade expressly reserved to the states by the Constitution; since, moreover, in general, powers not expressly delegated to the national government are reserved to the states and to the people, the act must be pronounced unconstitutional and void. In support of each of the contentions entering into this argument the precedent of previous decisions is cited, thus giving the argument the form of an invincible series of syllogisms. The Constitution gives the premises, whose authority is unquestioned; its meaning is interpreted by prior decisions; the reasoning is formally valid; therefore it would seem that the conclusion must be indubitable. At least it was so to five of the nine judges.

Opinion of the minority

But now let us see what the other four judges thought about the matter. Their opinion was stated in the following form by Mr. Justice Holmes:

> The single question in this case is whether Congress has power to prohibit the shipment in interstate or foreign commerce of any product of a cotton mill situated in the United States, in which within thirty days before the removal of the product children under fourteen have been employed, or children between fourteen and sixteen have been employed more than eight hours in a day, or more than six days in any week, or between seven in the evening and six in the morning. The objection urged against the power is that the States have exclusive control over their methods of production and that Congress cannot meddle with them, and taking the proposition in the sense of direct intermeddling I agree to it and suppose that no one denies it.

But if an act is within the powers specifically conferred upon Congress, it seems to me that it is not made any less constitutional because of the indirect effects that it may have, however obvious it may be that it will have those effects, and that we are not at liberty upon such grounds to hold it void.

The first step in my argument is to make plain what no one is likely to dispute—that the statute in question is within the power expressly given to Congress if considered only as to its immediate effects and that if invalid it is so only upon some collateral ground. The statute confines itself to prohibiting the carriage of certain goods in interstate or foreign commerce. Congress is given power to regulate such commerce in unqualified terms. It would not be argued today that the power to regulate does not include the power to prohibit. Regulation means the prohibition of something, and when interstate commerce is the matter to be regulated I cannot doubt that the regulation may prohibit any part of such commerce that Congress sees fit to forbid. At all events it is established by the *Lottery Case* and others that have followed it that a law is not beyond the regulative power of Congress merely because it prohibits certain transportation out and out. *Champion* v. *Ames*, 188 U. S. 321, 355, 359, *et seq.* So I repeat that this statute in its immediate operation is clearly within the Congress's constitutional power.

The question then is narrowed to whether the exercise of its otherwise constitutional power by Congress can be pronounced unconstitutional because of its possible reaction upon the conduct of the States in a matter upon which I have admitted that they are free from direct control. I should have thought that that matter had been disposed of so fully as to leave no room for doubt. I should have thought that the most conspicuous decisions of this court had made it clear that the power to regulate commerce and other constitutional powers could not be cut down or qualified by the fact that it might interfere with the carrying out of the domestic policy of any State.

The manufacture of oleomargarine is as much a matter of state regulation as the manufacture of cotton cloth. Congress levied a tax upon the compound when colored so as to resemble butter that was so great as obviously to prohibit the manufacture and sale. In a very elaborate discussion the present Chief Justice excluded any inquiry into the purpose of an act which apart from that purpose was within the power of Congress. *McCray* v. *United States*, 195 U. S. 27. As to foreign commerce, see *Weber* v. *Freed*, 239 U. S. 325, 329; *Brolan* v. *United States*, 236 U. S. 216, 217; *Buttfield* v. *Stranahan*, 192 U. S. 470. Fifty years ago a tax on state banks, the obvious purpose and actual effect of which was to drive them, or at least their circulation, out of existence, was sustained, although the result was one that Congress had no constitutional power to require. The Court made short work of the argument as to the purpose of the act. "The judicial cannot prescribe to the legislative department of the government limitations

upon the exercise of its acknowledged powers." *Veazie Bank* v. *Fennon*, 8 Wall. 533. So it might well have been argued that the corporation tax was intended under the guise of a revenue measure to secure a control not otherwise belonging to Congress, but the tax was sustained, and the objection so far as noticed was disposed of by citing *McCray* v. *United States*, *Flint* v. *Stone Tracy Co.*, 220 U. S. 107. And to come to cases upon interstate commerce, notwithstanding *United States* v. *E. C. Knight Co.*, 156 U. S. 1, the Sherman Act has been made an instrument for the breaking up of combinations in restraint of trade and monopolies, using the power to regulate commerce as a foothold, but not proceeding because that commerce was the end actually in mind. The objection that the control of the States over production was interfered with was urged again and again but always in vain. *Standard Oil Co.* v. *United States*, 221 U. S. 68, 69. *United States* v. *American Tobacco Co.*, 221 U. S. 106, 184. *Hoke* v. *United States*, 227 U. S. 308, 321, 322. See finally and especially *Seven Cases of Eckman's Alterative* v. *United States*, 239 U. S. 510, 514, 515.

The Pure Food and Drug Act which was sustained in *Hipolite Egg Co.* v. *United States*, 220 U. S. 45, with the intimation that "no trade can be carried on between the States to which it (the power of Congress to regulate commerce) does not extend," 57, applies not merely to articles that the changing opinions of the time condemn as intrinsically harmful, but to others innocent in themselves, simply on the ground that the order for them was induced by a preliminary fraud. *Weeks* v. *United States*, 245 U. S. 618. It does not matter whether the supposed evil precedes or follows the transportation. It is enough that in the opinion of Congress the transportation encourages the evil. . . . In *Clark Distilling Co.* v. *Western Maryland Ry. Co.*, 242 U. S. 311, 328, *Leisy* v. *Hardin*, 135 U. S. 100, 108, is quoted with seeming approval to the effect that "a subject matter which has been confided exclusively to Congress by the Constitution is not within the jurisdiction of the police power of the State, unless placed there by congressional action." I see no reason for that proposition not applying here.

The notion that prohibition is any less prohibition when applied to things now thought evil I do not understand. But if there is any matter upon which civilized countries have agreed—far more unanimously than they have in regard to intoxicants and some other matters over which this country is now emotionally aroused—it is the evil of premature and excessive child labor. I should have thought that if we were to introduce our own moral conceptions where in my opinion they do not belong, this was preëminently a case for upholding the exercise of all its powers by the United States.

But I had thought that the propriety of the exercise of a power admitted to exist in some cases was for the consideration of Congress alone, and that this Court always had disavowed the right to intrude its judgment upon questions of policy or morals. It is not for this Court to pronounce

when prohibition is necessary to regulation if it ever may be necessary—to say that it is permissible as against strong drink but not as against the product of ruined lives.

The act does not meddle with anything belonging to the States. They may regulate their internal affairs and their domestic commerce as they like. But when they seek to send their products across the state line they are no longer within their rights. If there were no Constitution and no Congress their power to cross the line would depend upon their neighbors. Under the Constitution such commerce belongs not to the States but to Congress to regulate. It may carry out its views of public policy whatever indirect effect they may have upon the activities of the States. Instead of being encountered by a prohibitive tariff at her boundaries the State encounters the public policy of the United States which it is for Congress to express. The public policy of the United States is shaped with a view to the benefit of the nation as a whole. If, as has been the case within the memory of men still living, a State should take a different view of the propriety of sustaining a lottery from that which generally prevails, I cannot believe that the fact would require a different decision from that reached in *Champion* v. *Ames*. Yet in that case it would be said with quite as much force as in this that Congress was attempting to intermeddle with the State's domestic affairs. The national welfare as understood by Congress may require a different attitude within its sphere from that of some self-seeking State. It seems to me entirely constitutional for Congress to enforce its understanding by all the means at its command.

Summary of the argument

Again let us summarize the argument. Congress is given the power to regulate interstate commerce in unqualified terms. Regulation is always the prohibition of something. Therefore an act is not beyond the regulative power of Congress merely because it prohibits the interstate transportation of certain goods. The question then comes to whether an otherwise constitutional act can be pronounced unconstitutional on account of its indirect effects upon the states in matters upon which the Constitution gives them power. But the most conspicuous decisions of this court have answered the question decidedly in the negative. It has been definitely held that the power over interstate commerce applies even to articles innocent in themselves when evils have been connected with them and interstate transportation encourages the evil. Hence the regulation of interstate commerce cannot be regarded as limited by its indirect effects upon the domestic policies of a state. And indeed we see that such

limitation would be entirely impossible if the Commerce Clause is to mean anything at all. Regulation of the conditions under which a state may carry on trade with other states must always place limits upon the domestic policies of a state. Whereas, if these domestic policies are to be allowed to wreak evil effects upon other states without any hindrance from congressional authority, we are in substance allowing the policies of certain states to control interstate commerce—a power to which they have no constitutional right. Since, then, the constitution clearly intended that when a state extends effects beyond its borders it must be controlled by the public policy of the entire nation, and since this is the case with the lax child-labor legislation of certain states, Congress was entirely within its rights under the Commerce Clause in passing the present act. Again, precedents are cited for each essential step, and most of them are cases also referred to by Mr. Justice Day.

How far this contradiction due to differences of evaluation

Which of these two groups of august judges was right? It is evident that they could not both be right, for the conclusions reached are contradictory. And how could we set up a standard which would indicate in some clear and objective way in all cases of this sort exactly the method of interpretation which alone is valid? We may give official power to the decision of one group by the simple device of making the majority opinion final. But this can hardly settle the matter for logic unless one subscribes to the notion that the mind of five judges out of nine must always be infallible and that of the other four intrinsically mistaken.

Where is the heart of the difficulty? Does it not lie again in the fact that the fundamental concepts used (and still more those covertly assumed) are value-concepts rather than merely descriptive terms, and that their meaning can accordingly not be determined in any given situation save through a process of valuation, with the variation of points of view which it inherently involves?

Let us compare the two arguments in the light of this supposition. Both appeal to the same Constitution, which is recognized as authoritative; both appeal to many of the same precedents,

which are recognized as giving an authoritative interpretation. Whence, then, this diametrical disagreement in their conclusions? As we examine the arguments, does it not become clear that the underlying issue on which they split is this: Where the exercise of the power explicitly given to Congress conflicts with the exercise of the power explicitly reserved to the states, which should give way? The majority group held that the former should give way, save in the case of certain exceptions clearly recognized by precedent. The minority group held that the latter should give way. On this issue, it is evident that the Constitution and prior precedent are ambiguous. If one keeps closely to the letter of previous precedents, the majority answer will be given; if one sees in them a more universal meaning, the latter answer will be apt to be given. How can we tell which side is right? Well, theoretically the judges are supposed to rest ultimately on the intention of the framers of the Constitution. But these framers are all dead, and their intentions doubtless differed as widely as those of the members of any constitutional convention. Historically it is clear that most of them were moved by a strong desire to uphold as far as possible the rights of the separate states, and this is so far forth a justification of the majority contention. But the powers given to Congress were categorical; moreover, if those constitution-makers could have foreseen the day when their problems would be things of the past and quite different ones challenge settlement, would they have wanted to insist so vigorously on state rights? How can we answer with confidence such a question? The only thing that we may be reasonably sure they would always want is the larger welfare of all the states consistently with the largest freedom of each. But to determine this means to engage in an active process of social evaluation ourselves in any concrete case that arises. It is to ask what will secure this envisioned social good in the light of just this situation. Accordingly, is it not clear that what the judge actually has to do when he faces every new situation is to give meaning anew by his own evaluating reflection to the fundamental concepts involved, restrained only by those elements of meaning in these

concepts which have been pretty securely fixed by tradition. But this means that his conclusions will be inevitably infected by his own notions of what the social welfare involves, and so far as such notions differ in different people through the variations of their experience and interest, how is it possible to establish an objective standard of correct thinking in these matters?

Legal terms expand in meaning with every use

Mr. Justice Holmes, in his dissenting opinion, says that the judge's own moral conceptions have no proper place in a legal decision, and intimates that the five colleagues who disagreed with him were illegitimately influenced by such biases. If our analysis is sound, neither group of judges could or did avoid such influence, for *no one can interpret the ultimate social evaluations of others in terms of concrete situations which they never faced, without going through a process of reflective evaluation himself,* in the course of which the concepts used inevitably gain new meaning as applied to these novel problems. But this is to say that legal thinking is never a simple syllogistic deduction, but is to some extent a determination of social ends. It accordingly runs afoul of all the logical difficulties of such determination and exemplifies in its own way the need and the challenge for the attainment of a real standard to guide and control such thinking.

Ambiguities of legal thinking illustrated by a case at common law

It will be helpful to compare with the above case one involving a different set of concepts. We select a case where the appeal is to principles of the common law.

The Passaic Print Works, a manufacturer of calicoes established in Passaic, New Jersey, appealed to court for damages against the Ely and Walker Dry-Goods Co. of St. Louis. The petition alleged that the defendants, who were jobbers in St. Louis, having on hand a limited quantity of calicoes of the brands which the plaintiff had been accustomed to sell in largest quantities to St. Louis jobbers, issued circulars to retail dealers, in which they offered to sell these brands, as long as their stock should last, at prices below those asked by the plaintiff of jobbers. The petition further stated that plaintiff was informed and believed that this action was taken by the defendants,

not for any legitimate trade purpose of their own, but for the purpose of injuring the business of the plaintiff; and that the action did in fact injure and destroy the plaintiff's trade in St. Louis and the adjacent territory, by causing other jobbers to cancel their orders to the plaintiff, and by compelling the plaintiff to reduce its prices to meet those charged by the defendant. The central question before the court accordingly was: is an act otherwise legitimate as a form of business competition made illegal by a malevolent motive, and does the evidence substantiate such a motive in the present case?

The majority opinion was as follows:[1]

**Extracts from the majority opinion**

. . . The owner of property, real or personal, has an undoubted right to sell it and to offer it for sale at whatever price he deems proper, although the effect of such offer may be to depreciate the market value of the commodity which he thus offers, and incidentally to occasion loss to third parties who have the same kind or species of property for sale. The right to offer property for sale, and to fix the price at which it may be bought, is incident to the ownership of property, and the loss which a third party sustains in consequence of the exercise of that right, is *damnum absque injuria*. We are thus confronted with the enquiry whether the motive which influenced the defendant company to offer for sale such calicoes of the plaintiff's manufacture as they had in stock at the price named in the circular, conceding such motive to have been as alleged in the complaint, changed the complexion of the act and rendered the same unlawful, when, but for the motive of the actor, it would have been clearly lawful.

After summarizing in the light of precedents the conditions under which a bad motive changes the legal complexion of an act, the opinion reaches the following conclusion:

It is wiser, therefore, to exclude any inquiry into the motives of men when their actions are lawful, except in those cases where it is well established that malice is an essential ingredient of the cause of action, or in those cases where, the act done being wrongful, proof of a bad motive will serve to exaggerate the damages.

The case at bar falls within neither of the exceptions to the general rule above stated—that, if an act is done in the exercise of an undoubted right, and is lawful, the motive of the actor is immaterial. No one can dispute the right of the defendant company to offer for sale goods that it owned and were in its possession, whether the quantity was great or small, for such a price as it deemed proper. This was the outward visible act of which complaint was made, and, being lawful, the court will not hold it to be

[1] 105 Fed. 163.

otherwise because of a secret purpose entertained by the defendant company to inflict loss on the plaintiff by compelling it to reduce the cost of a certain kind of its prints or calicoes.

The plea that in consequence of the act of the defendant certain jobbers were induced to break their contracts with the plaintiff is denied legal value on the ground that no names are mentioned of persons thus influenced, nor was it shown that jobbers were not privileged to cancel orders at pleasure. In the light of all relevant considerations, therefore, the decision is that the complaint did not state a cause of action.

From the dissenting opinion

One of the judges, however, presented a dissenting opinion.

. . . It is conceded that, if the defendant had advertised these prints for any legitimate trade purpose, for the purpose of selling them for gain for themselves, for the purpose of converting them into money because they preferred their advertised price to the goods, or for the purpose of competing in trade with the plaintiff, they would have had a justifiable cause for inflicting upon it the damages of which it complains, and these damages would then have been *damnum absque injuria.* But, if they had advertised them for any of these purposes, this case would have constituted an exception to the general rule of law. The general rule is, that whenever one injures a man's business, profession, or occupation he is liable for the damages he inflicts. The exception is that, where the injury is caused by competition in trade or the lawful exercise of a right which the inflictor has, then the injury is justifiable and no damages can be recovered. But, where such an injury is inflicted, the presumption always is that the rule, and not the exception, applies, and if the inflictor would justify, he must show that he falls within the exception. The question in this case, therefore, is not whether or not the motive or intent of the defendants will make acts unlawful which were otherwise lawful, but whether or not the intent and purpose of the defendants will justify an otherwise unlawful act, and excuse them from the payment of damages for which, under the general rule of law, they are liable to the plaintiff. It is whether or not the petition shows that they advertised the goods for legitimate trade purposes, so that their acts fell within the exception, which justifies the infliction of damages, and not under the general rule, which requires them to compensate the plaintiff for the injury they have caused. The opinion of the majority assumes that the defendants advertised the prints for a legitimate trade purpose, so that their acts fell within the exception to the general rule. It overlooks the legal presumption that injury to one's business entitles him to compensatory damages, and the plain averment of the petition that the acts of the defendants were not done for any justifiable cause, but were committed for the sole purpose of inflicting upon the plaintiff the injury they caused. . . .

> Now, no one will dispute the rules of law that the plaintiff in this action had the right to conduct its business of manufacturing and selling prints without the injurious interference of strangers, and that the defendants were subject to the universal rule that they must so use their own property and rights as to inflict no unnecessary injury upon their neighbors. The averments of this petition are that they were not using any of their property or exercising any of their rights for any legitimate trade purpose, but that they were using them for the express purpose of inflicting injury upon the plaintiff, and that they succeeded in imposing the infliction. These allegations seem to me to bring this case under the general rule of law, and to clearly negative the claim that it falls within the exception. . . .

The judge then cites a number of precedents, whose tenor is well summed up in the following statement from the Massachusetts Supreme Court, which he quotes:

> "Everyone has the right to enjoy the fruits and advantages of his own enterprise, industry, skill, and credit. He has no right to be protected against competition, but he has a right to be free from malicious and wanton interference, disturbance, or annoyance. If disturbance or loss come as a result of competition, or the exercise of like rights by others, it is *damnum absque injuria*, unless some superior right by contract or otherwise is interfered with. But, if it come from the merely wanton or malicious acts of others, without the justification of competition or the service of any interest or lawful purpose, it then stands upon a different footing. . . ."
>
> Under the legal principles to which reference has been made, and under the authorities which have been cited, the petition in this case states a good cause of action for interference with and injury to the business of the plaintiff by preventing it from obtaining custom it would otherwise have obtained, without any justifiable cause or excuse, and for this reason the demurrer should have been overruled, and the case sent to trial.

Nature of the issue —how shall such be standardized?

Here the fundamental assumption of the majority opinion is that motives are legally immaterial as long as the acts committed are ones which might naturally be committed in the pursuance of an undoubted legal right such as that of business competition. The assumption of the minority opinion is that injury warrants damages except in those cases where the injury can be clearly shown to be justified by a legal right such as that of competition. It would not be so justified, it is held, if the motive is not one of genuine competition.

Again, how can we tell which of these contrasting assumptions is correct? Was it not likely that acceptance of them was in

each case conditioned by the judge's conception of which principle is of the more fundamental social importance and therefore expresses the deeper spirit of the common law? In what direction are we to move if we are to secure greater objectivity in these legal decisions?

EXERCISE.—Compare with the last of the two cases cited in the text the following case decided by the Supreme Court of Minnesota on February 19,1909 (107 Minn. 145). The student will notice that the contention of the minority in the St. Louis case here becomes that of the majority. But the injury is of course different. Just what is this difference, in general ethical terms, and how important is it? Just what are the controlling assumptions?

The plaintiff is a barber in the village of Howard Lake, Minnesota. He complains that the defendant, a banker and man of wealth and influence in the community, maliciously established a barber shop in the same village, employed a barber to carry on the business, and used his personal influence to attract customers from the plaintiff's barber shop, not at all to serve any legitimate purpose of his own by the profits of the tonsorial profession, but for the sole purpose of maliciously injuring the plaintiff, whereby the latter's business is being ruined. The question is, whether this injury is a cause of legal action.

The majority of the court decided that it was a cause of action. Mr. Justice Elliott stated the opinion, in part, in the following terms:

"It has been said that the law deals only with externals, and that a lawful act cannot be made the foundation of an action because it was done with an evil motive. . . . In *Jenkins* v. *Fowler*, 22 Pa. 308, Mr. Justice Black said that 'mischievous motives make a bad case worse, but they cannot make that wrong which in its own essence is lawful.' [Other precedents are cited.] Such generalizations are of little value in determining concrete cases. They may state the truth, but not the whole truth. Each word and phrase used therein may require limitation and definition. Thus, before we can apply Judge Black's language to a particular case, we must determine what act is 'in its own essence lawful.' . . . It is not at all correct to say that the motive with which an act is done is always immaterial, providing the act itself is not unlawful. Numerous illustrations of the contrary will be found in the civil as well as the criminal law.

". . . It must be remembered that the common law is the result of growth, and that its development has been determined by the social needs of the community which it governs. It is the resultant of conflicting social forces, and those forces which are for the time dominant leave their impress upon the law. It is of judicial origin, and seeks to establish doctrines and rules for the determination, protection, and enforcement of legal rights. Manifestly it must change as society changes and new rights are recognized. To be an

efficient instrument and not a mere abstraction, it must gradually adapt itself to changed conditions. Necessarily its form and substance have been greatly affected by prevalent economic theories. For generations there has been a practical agreement upon the proposition that competition in trade and business is desirable, and this idea has found expression in the decisions of the courts as well as the statutes. But it has led to grievous and manifold wrongs to individuals, and many courts have manifested an earnest desire to protect the individuals from the evils which result from unrestrained business competition. The problem has been to so adjust matters as to preserve the principle of competition, and yet guard against its abuse to the unnecessary injury to the individual. So the principle that one may use his own property according to his own needs and desires, while true in the abstract, is subject to many limitations in the concrete. Men cannot always, in civilized society, be allowed to use their own property as their interests or desires may dictate without reference to the fact that they have neighbors whose rights are as sacred as their own. The existence and well-being of society require that each and every person shall conduct himself consistently with the fact that he is a social and reasonable person. The purpose for which a man is using his own property may thus sometimes determine his rights. . . . [Precedents are cited.]

The statement of Lord Bowen is approvingly referred to that, "at common law there was a cause of action whenever one person did damage to another, wilfully and intentionally, without just cause and excuse." Mr. Justice Elliott then cites a decision of Mr. Justice Hammond in the following words:

"It is said also that, where one has the lawful right to do a thing, the motive by which he is actuated is immaterial. One form of this statement appears in the first headnote of *Allen* v. *Flood*, as reported in A.C.1, as follows: 'An act lawful in itself is not converted by a malicious or bad motive into an unlawful act, so as to make the doer of the act liable to a civil action.' If the meaning of this and similar expressions is that, where a person has the lawful right to do a thing irrespective of his motive, his motive is immaterial, the proposition is a mere truism. If, however, the meaning is that where a person, if actuated by one kind of a motive, has a lawful right to do a thing, the act is lawful when done under any conceivable motive, or that an act lawful under one set of circumstances is therefore lawful under every conceivable set of circumstances, the proposition does not commend itself to us as either logically or legally accurate."

Mr. Justice Elliott refers to other decisions of the same tenor, and then continues:

"It is freely conceded that there are many decisions contrary to this view; but when carried to the extent contended for by the appellant, we think they are unsafe, unsound, and illy adapted to modern conditions. To divert to one's self the customers of a business rival by the offer of goods at lower

prices is in general a legitimate mode of serving one's own interest, and justifiable as fair competition. But when a man starts an opposition place of business, not for the sake of profit to himself, but regardless of loss to himself, and for the sole purpose of driving his competitor out of business, and with the intention of himself retiring upon the accomplishment of his malevolent purpose, he is guilty of a wanton wrong and an actionable tort. In such a case he would not be exercising his legal right, or doing an act which can be judged separately from the motive which actuated him. To call such action competition is a perversion of terms. It is simply the application of force without legal justification, which in its moral quality may be no better than highway robbery."

The majority opinion, therefore, is that in these circumstances the motive behind the act made a legal difference, and the order of the lower court holding the banker's conduct a cause of action is affirmed. Mr. Justice Elliott himself, however, and one of the other justices, dissented from the majority view. Their minority opinion is stated briefly by Mr. Justice Elliott in the following paragraph:

"Nevertheless, in the opinion of the writer this complaint is insufficient. It is not claimed that it states a cause of action for slander. No question of conspiracy or combination is involved. Stripped of the adjectives and the statement that what was done was for the sole purpose of injuring the plaintiff, and not for the purpose of serving a legitimate purpose of the defendant, the complaint states facts which in themselves amount only to an ordinary everyday business transaction. There is no allegation that the defendant was intentionally running the business at a financial loss to himself, or that, after driving the plaintiff out of business, the defendant closed up or intended to close up, his shop. From all that appears from the complaint he may have opened the barber shop, energetically sought business from his acquaintances and the customers of the plaintiff, and, as a result of his enterprise and command of capital, obtained it, with the result that the plaintiff, from want of capital, acquaintance, or enterprise, was unable to stand the competition, and was thus driven out of business. The facts thus alleged do not, in my opinion, in themselves, without reference to the way in which they are characterized by the pleader, tend to show a malicious and wanton wrong to the plaintiff."

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## CHAPTER SEVENTEEN

# LOGICAL PROBLEMS IN HISTORICAL EXPLANATION

Is history scientific?

LET us turn now to two fields in which many will feel that the guiding hypothesis of this section has little or no pertinence. Can not the historian be completely emancipated from the necessity of introducing evaluation into his professional thinking? His business, we might say, is simply to describe in quite impartial fashion what has actually happened, not what he thinks ought to have happened or would have happened had he been in charge of the events in question. What hinders him, then, from taking a wholly objective and factual point of view similar to that of the natural scientist? Like the scientist, he seeks truth as an already determining end rather than one whose significance his own thinking is to establish, and every event which he seeks to understand is a definite, indubitable fact.

Many writers of history have, of course, approached their task with the assumption that all they need to do is to gather faithfully all the facts that emerge and string them together in proper temporal sequence. Their ideal of history is what we might term a series of annals, made as complete as the records handed down from the period in question permit. But let us see how such an attempt fares. In fact, the historian who tries to carry through a program of this kind soon finds himself involved in a twofold difficulty.

Historical thinking selective

To begin with, he finds that in spite of his desire to make his story quite impartial he is none the less selecting the material he presents from a much wider field of possible happenings, for it is no more possible to stare in complete diffuseness at the past than it is to have one's attention equally caught by every

form and color in a present landscape. Some particular event first arouses his special interest, and he can no more study other events without a peculiar eye for their explanatory value in relation to this event, than can the scientist's observations and experiments fail to be guided by the particular hypothesis which he is interested in testing. But all these distinguishable events have an infinity of relations with each other which might be followed up for purposes of explanation; accordingly, in the very preliminary amassing of his material, the historian is engaging in a selective process, which, unless two historians entirely agree in the kind and degree of interest they take in the event with which they begin, will take form rather differently in the course of their investigations.

**How does one event historically explain another?**

At least this will be the case unless they can agree precisely on what is meant by saying that one historical event explains another—is to be construed, in short, as its cause. This brings us to the second difficulty, and with the analysis of the main factors which constitute this difficulty we are in the heart of the logical problem of historical writing. For the natural scientist, too, has to engage in the selective process noted above, but in scientific investigations it has fortunately become much clearer what we mean by saying that one thing is the cause of another; at least, scientists agree sufficiently to accept unanimously a certain method of approach and a certain type of experimental technique as yielding sound causal laws wherever it can be successfully applied. As the student familiar with history knows, and the illustrations soon to be given prove, nothing of the sort has so far been achieved in historical investigation. Why is it that the historian finds it much more perplexing to reach agreement on what he means by a causal explanation and to state objectively a logical standard?

**History never repeats itself**

We must note first that nothing like overt experimentation is possible in the field dealt with by the historian. The past is, by definition, that which is beyond our active control; we cannot obviously restage a great complex of happenings like the American Civil War and see by present sense-observation the answer to our historical questions. And if we wait for nature to pre-

sent us with an exact duplicate of some interesting historical circumstance our wait is vain indeed. History never exactly repeats itself. The factors conditioning any single happening of importance are so numerous and complex that it is hopeless to expect them all to recur in the same way, at least for many æons of time. Moreover, in the life of the same race on the same planet, there is good ground for supposing that the essential structure of human nature forbids any such recurrence. For the events in which the historian takes interest are large-scale changes in human relations, actively and consciously participated in by many of the individuals affected by them, and accordingly the memory of an earlier event, handed down to succeeding generations by tradition, would itself introduce a novel conditioning factor in the second event, otherwise wholly similar to the first.

**Hence scientific generalizations impossible in history**

This amounts to saying that the historian faces at the outset of his work the impossibility of verifying any exact and indubitable laws relating the occurrences which he studies, such as the scientist is able to discover, for such laws depend on abstracting from the total passage of history groups of events which do recur, like the fall of the rain and the growth of the grass, the northerly advance of the sun and the rise of the average temperature, and the degree of their exactitude depends on the degree of our ability to isolate them under controlled conditions and determine by experiment the influence of each factor. In short, the historian is trying to find the cause of an event which never happens twice and whose totality, therefore, transcends scientific law and method. Many of its elements, however, constantly recur, and give clues to the masses of circumstance within which we are to ferret out what we shall call its cause.

If even this were all of the difficulty we might regard history as furnishing the logical limit to social science in general, and therefore revealing only the same perplexities which all social scientists face, pushed to the extreme of bafflement. For let us note certain relations between the two disciplines. As the social scientist approaches situations of great complexity, such, for example, as the phenomena of nonvoting earlier discussed, he finds

the relevant causal factors so numerous and so uncontrollable that the best that he can do is to neglect the less important of them and keep the others as constant as possible (except the one variable which he wishes to study). None the less, when the limit is reached of an absolutely unique, induplicable event, as is the case with the historian, we find ourselves in a fundamentally different situation from the logical standpoint. After all, however complex and difficult to control the problem of non-voting, it is still a definitely recurring fact in different elections, which, as thus a recurrent phenomenon, the political scientist is interested in explaining. The law he seeks is accordingly a scientific law in the strict sense of the term—a generalization applying to many particulars. But the historian aims at nothing less than the understanding of a given event as an inherently individual occurrence, as something which he does not expect at all to occur again. He cannot experiment; the methods of statistics and correlation are ultimately helpless for his purpose; his ideal is not even to abstract at all, but to face the whole event in all its bewildering and irreducible complexity.

But why assume that the difficulty is one of evaluation?

What now justifies the assumption, second, that evaluation plays an inevitable rôle in historical interpretation? In practice we find it impossible to get far in interpreting what people do, whether as individuals or in groups, without asking what it was that they wanted in the situation in question. For as conscious beings, possessed of memory and imagination, men are constantly dealing with desired ends, and adjusting means to their attainment. Especially is this true, of course, when we neglect their daydreams and merely habitual activities and turn to those large-scale shifts in human relations which draw our special interest and appeal to the historian as weighty happenings to interpret. With such revolutions in the course of human events we can apparently make no headway at all without asking what it was that the persons concerned were trying to accomplish in these endeavors and struggles; what goals, first of all, were the leaders pursuing; and then what desirable things were their followers expecting to gain in supporting their venture? In other words, it is largely in terms of

the ends desired by the participants in these transformations in human affairs that we find it necessary to couch our causal explanations, in the same way that we have to appeal to such wants in accounting for most of the definite performances of individuals.

Human wants, for psychology, for history

Now the science of psychology is yielding increasingly accurate information as to what most people want in normal and specific—that is, recurrent—situations. And this enables us to turn constantly for helpful clues in our historical interpretations to the best social psychology available in our time, in fact, a comparison of the histories of our own time with those of earlier generations reveals the difference in psychological viewpoint more clearly than it reveals anything else. But psychology endeavors to be a science. It is endeavoring increasingly to gain the same kind of objectivity that other sciences have attained. This means, among other things, that the explanatory entities to which it appeals must be so abstracted from the complexes in which they appear that they can recur in different situations, and their relations become formulated in terms of objective, universal law. If in its progress in this direction psychology continues to speak of wants or desires as explaining what happens in recurrent situations it must try to mean by these wants something which can be repeated in an objectively verifiable way. But this is not exactly what the historian can mean when he appeals to what people want as an explanation of the great events in history. For as such events in all their complexity are unique and unrepeatable, so the wants conditioned by that complexity are unique and unrepeatable, even though in many cases our poverty of language may force us to describe them by the same general term. Both the Dutch in their wars with Philip and the American colonists in their war with George III were fighting for liberty in some sense, but it is surely obvious that the precise content of the term liberty in these two cases is not the same. Nobody can want exactly the same thing in two different situations, for his want is conditioned by the present event in relation to the whole of his past experience; still less can two different groups of people want exactly the same thing in varying

historical contexts. But the historian, unlike the scientist, is trying nothing less than to explain entire complexes of events, which are always different, largely in terms of human wants which for that very reason are also always different.

A novelistic element then inevitable in history

If this be a true account of his task it is evident that his method of procedure must be essentially different from that of the social psychologist. How shall he conceive what people were struggling for in the great crises in human affairs which arouse his interest? If he says that they were struggling for liberty, or for foreign markets, or for national glory, how shall he give precision of meaning to these value-concepts as he uses them in any given historical context? Apparently in the only way in which we have now discovered it possible to give meaning to such ideas, namely, he must engage to some extent in a process of valuation himself every time he uses them—he must immerse himself in the records of his period and feel his way sympathetically into the living situation which he is seeking to interpret. On the basis of what the participants were doing and saying he must try to enter directly and intimately into the consciousness that accompanied their deeds. And how can this essentially intuitive, sympathetic insight remain uncolored by his own evaluation of social ends? As he broadens his grasp of the factors conditioning their situation his own feeling must vibrate appreciatively with their needs and ambitions; he understands what they must have wanted because he realizes in terms of his own present share in their evaluating activity what it was that they could not avoid wanting. And is there not palpable evidence on every page of history that something like this goes on in the thinking of the historian? History is a story, not a scientific analysis; a novel founded on fact, not a mere series of facts themselves. Of course it must respect the records of the past. It must make painstaking use of all the tools and results of social science. Otherwise it will be a mere drama, not history. But as history it must transcend these generalizing processes, and in doing so it inevitably enhances the play of personal evaluation in the historian's thinking. If, then, such evaluation plays a vital part in the historian's work, we shall

expect that his portrayal of a given event will reveal not only the general assumptions about social psychology that prevail in his intellectual environment, but also the peculiarities of his own interpretation of social ends as conditioned by the range and quality of his individual experience.

Illustration from contrasting interpretations of the American Constitution

The extent to which this situation actually obtains in historical writing is well revealed by a comparison of two widely different interpretations of the causes of some outstanding historical occurrence, such as the adoption of the Constitution of the United States.

The contrasting interpretations selected will be that of C. A. Beard, offered in his *Economic Interpretation of the Constitution of the United States,* and that of A. C. McLaughlin, in *The Confederation and the Constitution.*

Let us begin with representative quotations from Beard.[1]

The interpretation of Beard

. . . The inquiry which follows is based upon the political science of James Madison, the father of the Constitution and later President of the Union he had done so much to create. This political science runs through all of his really serious writings and is formulated in its most precise fashion in *The Federalist* as follows: "The diversity in the faculties of men, from which the rights of property originate, is not less an insuperable obstacle to a uniformity of interests. The protection of these faculties is the first object of government. From the protection of different and unequal faculties of acquiring property, the possession of different degrees and kinds of property immediately results; and from the influence of these on the sentiments and views of the respective proprietors, ensues a division of society into different interests and parties. . . . The most common and durable source of factions has been the various and unequal distribution of property. Those who hold and those who are without property have ever formed distinct interests in society. Those who are creditors, and those who are debtors, fall under a like discrimination. A landed interest, a manufacturing interest, a mercantile interest, a moneyed interest, with many lesser interests, grow up of necessity in civilized nations and divide them into different classes, actuated by different sentiments and views. The regulation of these various and interfering interests forms the principal task of modern legislation, and involves the spirit of party and faction in the necessary and ordinary operations of the government."

Here we have a masterly statement of the theory of economic determinism in politics. Different degrees and kinds of property inevitably exist

[1] Pp. 14ff, 188, 250ff, 324ff. Reprinted by permission of The Macmillan Co. (Copyright 1913.)

in modern society; party doctrines and "principles" originate in the sentiments and views which the possession of various kinds of property creates in the minds of the possessors; class and group divisions based on property lie at the basis of modern government; and politics and constitutional law are inevitably a reflex of these contending interests. . . .

The requirements for an economic interpretation of the formation and adoption of the Constitution may be stated in a hypothetical proposition which, although it cannot be verified absolutely from ascertainable data, will at once illustrate the problem and furnish a guide to research and generalization.

It will be admitted without controversy that the Constitution was the creation of a certain number of men, and it was opposed by a certain number of men. . . .

Suppose it could be shown from the classification of the men who supported and opposed the Constitution that there was no line of property division at all; that is, that men owning substantially the same amounts of the same kinds of property were equally divided on the matter of adoption or rejection—it would then become apparent that the Constitution had no ascertainable relation to economic groups or classes, but was the product of some abstract causes remote from the chief business of life—gaining a livelihood.

Suppose, on the other hand, that substantially all of the merchants, moneylenders, security holders, manufacturers, shippers, capitalists, and financiers and their professional associates are to be found on one side in support of the Constitution, and that substantially all or the major portion of the opposition came from the nonslaveholding farmers and the debtors—would it not be pretty conclusively demonstrated that our fundamental law was not the product of an abstraction known as the "whole people," but of a group of economic interests which must have expected beneficial results from its adoption? Obviously all the facts here desired cannot be discovered, but the data presented in the following chapters bear out the latter hypothesis, and thus a reasonable presumption in favor of the theory is created. . . .

In the succeeding chapters, which are too detailed for helpful quotation, Beard attempts to show from an analysis of the forces leading up to the Constitutional Convention, the interests represented in the Convention itself, and the factors influencing the ratification of the new Constitution, that the fundamental issue between the Constitutionalists and their opponents was that between the interests of security, land, and slaveholders on the one side, who sought greater economic stability, the full repayment of debts, and the adequate protection of land holdings, and the interests of the small farmers and debtors, who wanted

freedom from heavy taxation and generous concessions in the repayment of obligations. As illustrating the type of result reached, we may quote briefly from the conclusion of the chapter describing the ratification of the Constitution. After presenting figures showing that only a very small number of adult males voted in the election of delegates to the state ratifying conventions, Beard says:

> Admitting that these figures are rough guesses, it appears, nevertheless, that the Constitution was not "an expression of the clear and deliberate will of the whole people," nor of a majority of the adult males, nor at the outside of one-fifth of them.
>
> Indeed, it may very well be that a majority of those who voted were against the adoption of the Constitution as it then stood. Such a conjecture can be based on the frank statement of no less an authority than the great Chief Justice Marshall, who took a prominent part in the movement which led to the formation and ratification of the new instrument of government.
>
> At all events, the disfranchisement of the masses through property qualifications and ignorance and apathy contributed largely to the facility with which the personalty-interest representatives carried the day. The latter were alert everywhere, for they knew, not as a matter of theory, but as a practical matter of dollars and cents, the value of the new Constitution. They were well informed. They were conscious of the identity of their interests. They were well organized. They knew for weeks in advance, even before the Constitution was sent to the states for ratification, what the real nature of the contest was. They resided for the most part in the towns, or the more thickly populated areas, and they could marshal their forces quickly and effectively. . . .
>
> Talent, wealth, and professional abilities were, generally speaking, on the side of the Constitutionalists. The money to be spent in the campaign of education was on their side also; and it was spent in considerable sums for pamphleteering, organizing parades and demonstrations, and engaging the interest of the press. A small percentage of the enormous gain to come through the appreciation of securities alone would have financed no mean campaign for those days.
>
> The opposition on the other hand suffered from the difficulties connected with getting a backwoods vote out to the town and county elections. This involved sometimes long journeys in bad weather, for it will be remembered that the elections were held in the late fall and winter. There were no such immediate personal gains to be made through the defeat of the Constitution, as were to be made by the security-holders on the other side. It was true the debtors knew that they would probably have to settle their accounts in full and the small farmers were aware that taxes would have to be paid to

discharge the national debt if the Constitution was adopted; and the debtors everywhere waged war against the Constitution—of this there is plenty of evidence. But they had no money to carry on their campaign—they were poor and uninfluential—the strongest battalions were not on their side. The wonder is that they came so near defeating the Constitution at the polls.

At the end of the volume Beard summarizes the conclusions which, he holds, the data presented appear to warrant.

The movement for the Constitution of the United States was originated and carried through principally by four groups of personalty interests which had been adversely affected under the Articles of Confederation: money, public securities, manufactures, and trade and shipping.

The first firm steps toward the formation of the Constitution were taken by a small and active group of men immediately interested through their personal possessions in the outcome of their labors.

No popular vote was taken directly or indirectly on the proposition to call the Convention which drafted the Constitution.

A large propertyless mass was, under the prevailing suffrage qualifications, excluded at the outset from participation (through representatives) in the work of framing the Constitution.

The members of the Philadelphia Convention which drafted the Constitution were, with a few exceptions, immediately, directly, and personally interested in, and derived economic advantages from, the establishment of the new system.

The Constitution was essentially an economic document based upon the concept that the fundamental private rights of property are anterior to government and morally beyond the reach of popular majorities.

The major portion of the members of the Convention are on record as recognizing the claim of property to a special and defensive position in the Constitution.

In the ratification of the Constitution, about three-fourths of the adult males failed to vote on the question, having abstained from the elections at which delegates to the state conventions were chosen, either on account of their indifference or their disfranchisement by property qualifications.

The Constitution was ratified by a vote of probably not more than one-sixth of the adult males.

It is questionable whether a majority of the voters participating in the elections for the state conventions in New York, Massachusetts, New Hampshire, Virginia, and South Carolina, actually approved the ratification of the Constitution.

The leaders who supported the Constitution in the ratifying conventions represented the same economic group as the members of the Philadelphia

Convention; and in a large number of instances they were also directly and personally interested in the outcome of their efforts.

In the ratification, it became manifest that the line of cleavage for and against the Constitution was between substantial personalty interests on the one hand and the small farming and debtor interests on the other.

The Constitution was not created by "the whole people" as the jurists have said; neither was it created by "the states" as Southern nullifiers long contended; but it was the work of a consolidated group whose interests knew no state boundaries and were truly national in their scope.

The second of the two original hypotheses he thus regards as conclusively verified within the limits set by the data.

To carry the theory of the economic interpretation of the Constitution out into its ultimate details would require a monumental commentary, such as lies completely beyond the scope of this volume. But enough has been said to show that the concept of the Constitution as a piece of abstract legislation reflecting no group interests and recognizing no economic antagonisms is entirely false. It was an economic document drawn with superb skill by men whose property interests were immediately at stake; and as such it appealed directly and unerringly to identical interests in the country at large.

interpretation of McLaughlin

McLaughlin, however, finds the chief cause of the establishment of the Constitution in the persistence, after the Revolution, of the individualistic and rebellious tendencies which had gained expression during the war, and particularly in the general impotence of the federal Congress in the face of practically unimpaired sovreignty on the part of the separate states. These matters taught intelligent men (not of any special class economically) that the future existence and strength of the colonies were dependent upon replacing the Articles of Confederation by a document establishing some more authoritative central power.[1]

Experience, it is plain, had before 1786 taught the necessity of bestowing on some central authority the power to regulate commerce and the power to obtain revenue without merely begging for it. Every passing year since the adoption of the Articles had shown more clearly that these two powers should have been given to Congress, because without the latter Congress was impotent and ridiculous, and without the former it had no method of meeting the exactions of European nations. It was compelled to look on helplessly while the states working at cross-purposes were angrily trying to retaliate against foreign restrictions, or at the next turn of the wheel of popular caprice were threatening their neighbors with commercial war. The

[1] The ensuing quotations are from pp. 173ff, 272ff, 278ff, and 316. Published by Harper & Brothers.

necessity of bestowing such powers was clear, for the lesson had been sharply taught, and though of course it was not learned by the ignorant or the narrow-minded, it was obvious to the intelligent statesmen and men of affairs, who were not yet prepared to give up their country to civil war and ruin. At least this much of the great task of imperial organization had been made clear by the troublesome years of war and the no less anxious years of peace.

But there were plainly other troubles. Congress had been given power to make treaties, but this power could not be properly exercised; and our commissioners, confident and loyal as they were, could not negotiate with assurance or make equitable treaties as long as the states, feeling that they were quite as wise as Congress, were ready to disregard all foreign obligations when they chose. Our relations with Spain and England were fraught with danger. Surely, if commerce was to prosper, if the country was to hold up its head among the nations, the states must be under compulsion to perform their parts, to abide by the promises of Congress, and not wantonly break the plighted faith of their representatives. In the formation of lasting political order in America some method must be discovered for securing the observance of treaties; without assurance of honesty any confederation of any national system would be but sounding brass.

This was clear, and thinking men went further; they saw that, if America was to hold together, more than mere promise and pledge was an absolute necessity. Not for treaties alone, but for other obligations as well, for the satisfactory exercise of the powers given to Congress, there must be some sort of compulsive authority.

Since the movement thus began largely as a means of curtailing the selfishly exercised powers of the separate states, McLaughlin finds that the debates at the Constitutional Convention were mainly struggles between representatives of the larger states, who were eager for proportional representation in the new Congress, and those of the smaller states, who held out for state equality. These struggles were finally ironed out in compromise, and the document went forth for ratification to the state conventions. Of the Constitution thus conceived McLaughlin says:

The document to which the framers attached their names with mingled hopes and misgivings that September day in the old statehouse in Philadelphia has come to be looked on as one of the great documents of the world's history; it is now the fundamental law of the oldest republic on earth; the government which it established has outlived dynasties and seen ancient governments totter; it has stood without destruction while England was abandoning her old-time aristocratic government, while France was making and remaking a series of constitutions, while Italy was unified and the German

people were founding a national organization, while the Pope himself was deprived of his ancient temporal authority, while Spain, who at one time claimed nearly the whole of the New World, was losing her dominions and shrinking back into the old limits of the Iberian peninsula.

The Constitution has sometimes been spoken of as if it were in all respects the creature of the men at Philadelphia, or as if it were, as Mr. Gladstone once said, "the most wonderful work ever struck off at a given time by the brain and purpose of man." . . . The idea that they created institutions out of nothingness loses sight of the manner and the conditions of their work. . . . But there is no evidence of borrowing or of slavish copying; for, while they were students and readers of history and knew that their own little experience was not the sum of knowledge, they were practical political workers, had for years studied the problems of forming governments, and had been acquainted with the great process of making state constitutions. The men of the generation who declared independence and formed new states were steeped in political theory as their great-grandfathers had been in theology, and for years they were engaged in the difficult process of adapting old institutions to new ideas, framing governments and laws that suited the economic, social, and moral conditions which the New World had produced.

We might, therefore, expect to find from these experienced craftsmen, not a document hurriedly patched together, nor one taken in part from distant ages or strange crimes, but an American document, in its entirety new, but made up of parts that had found their places in the state organizations. If we look, then, for the origin of the Constitution, we find much of it in the failures of the Confederation, in the tribulations of eleven confused years, when the nation was without a proper government and when distress and disorder and incompetence were showing the way to success; and much of it, too, in the state constitutions which had been drawn up by men familiar with colonial governments and administration. . . .

And thus it may be said that colonial history made the Constitution. Even in the division of authority between the states and the national government we see a readjustment of the old practical relationship between colonies and mother-country, a readjustment which was based in part on the imperfections of the old system, but carried out the teachings of the Revolution. Even the essentially American notion, the notion that government is the agent of the people and must not transcend the law set by the people, was an outgrowth of the free society of a new world, had found its expression in the theory of the Revolution, and had arisen in a country in which from time immemorial there had been no government possessed of all political power. And this only means, of course, that the Constitution of the United States took its root in the history of England; it was not borrowed by conscious imitation of England; it was a product of the forces of English history; but it was shaped by American necessities, was framed by men who

could learn lessons and use the material the tide of history washed to their feet.

Whence came the opposition to the ratification of the Constitution?

In truth, the Constitution had many foes to meet. There was a little band of irreconcilables who could see no good in making the central authority efficient, who had always opposed the extension of national authority, and knew not how else to act. There were men of wide influence, like Samuel Adams, who had said so much about liberty that they were not conversant with the arguments for government. There were those who had already begun to cherish sectional antagonism, fearing the development of the west, or disliking the growing power of commercial New England. There were the paper-money men and the discontented needy, who saw in the Constitution a prohibition of bills of credit and of laws impairing the obligation of contracts—a party which had just been successful in controlling the legislatures of seven states. There were those who had been indignant at the proposition to close the Mississippi and were in no mood to see federal power increased and the full right to make treaties bestowed on the central government. There was the body of the people who for a generation had listened to the enchanting oratory of liberty and could be easily aroused to dread. There were those who, living away from the busy sources of trade, saw no need of a central government with wide power of taxation and authority to regulate commerce. No one of these elements was dangerous alone, but together they constituted a party of opposition which was aided, of course, by the big body of hesitants who at such times pause and shake their heads and wonder if it would not be best to let well enough alone. Fortunately, to leave bad enough alone was the alternative, and every day was sure to bring a few thoughtful reluctants to the support of the new Constitution.

Thus in time the Constitution was ratified. The far-seeing statesmen who sponsored it lost no opportunity to press its rational claims upon their hesitant fellows; in states where the opposition was strong they patiently won over yet dubious respected leaders to their cause, as Adams and Hancock in Massachusetts, before the matter was brought to a vote; the alternatives to the essential structure of the new document were so clearly discredited that the refractory elements were finally overcome.

In the twelve years that followed the Declaration of Independence the American people had accomplished much. The war was carried to a suc-

cessful conclusion; the settlements stretching along the Atlantic coast came into the possession of a wide territory extending over the mountains to the Mississippi; state constitutions, laying down broad principles of liberty and justice, were formed on lines of permanence; a new colonial system for the organization and government of the great west was formulated, a system that was to be of incalculable value in the process of occupying the continent and building up a mighty republic; new settlements that showed capacity for self-government and growth were made in the wilderness beyond the Alleghanies. And finally, a federal Constitution was formed, having for its purpose the preservation of local rights, the establishment of national authority, the reconciliation of the particular interests and the general welfare. In solving the problem of imperial organization, America made a momentous contribution to the political knowledge of mankind.

**Summary of the issue**

As interpretations of the same sequence of historical events these two accounts are pretty nearly irreconcilable. Yet both are written by able men, living in the same period of historiography, and possessing an equal command of the relevant historical materials. To Beard the fundamental thing that men want is economic security and prosperity. All other motives, in his opinion, are so far subordinate to this that every great change in history must be regarded as moved fundamentally by such economic interests and explicable in terms of them. McLaughlin, on the other hand, recognizes a greater diversity of interests as each playing an important rôle on the pages of history; in bringing about the adoption of the Constitution there coöperated with the economic motive, as equal to it in historical importance, such demands as those for stability, for national aggrandizement and effectiveness in dealing with the European nations, and for the equitable adjustment of state jealousies.

**Which is more nearly right? How can we tell?**

Which of these interpretations is right? How can we answer such questions? What objective standard can be set up to control our thinking when we attempt to write history? Must there be an irreducible element of personal valuation in our interpretation of these dramatic occurrences in human affairs, which will continue to perplex us in our endeavor to understand them in terms that others, too, can recognize as valid, in essentially the same way that it does in every determination of ends? What is the solution of this challenge to our logic?

EXERCISE.—Study the following quotations from George Bancroft's *History of the United States* and from C. M. Andrews' *Colonial Background of the American Revolution*, respecting the causes of the Revolutionary War. State clearly the fundamental difference in guiding assumptions. It will be observed that Bancroft represents an earlier period in historiography than Andrews. How far does this account for the difference between them? How far does it rest on differences of personal evaluation?

Discussing the battle of Concord and the way in which the news spread throughout the Colonies, Bancroft says:

"The American revolution grew out of the soul of the people and was an inevitable result of a living affection for freedom, which set in motion harmonious effort as certainly as the beating of the heart sends warmth and color through the system. The rustic heroes of that hour obeyed the simplest, the highest, and the surest instincts of which the seminal principal existed in all their countrymen. From necessity they were impelled toward independence and self-direction; this day revealed the plastic will which was to attract the elements of a nation to a center, and by an innate force to shape its constitution. . . .

"Darkness closed upon the country and upon the town, but it was no night for sleep. Heralds by swift relays transmitted the war message from hand to hand, till village repeated it to village; the sea to the backwoods; the plains to the highlands; and it was never suffered to droop till it had been borne north and south, and east and west, throughout the land. It spread over the bays that received the Saco and the Penobscot and the St. John's. Its loud reveille broke the rest of the trappers of New Hampshire, and, ringing like bugle-notes from peak to peak, overleapt the Green Mountains, swept onward to Montreal, and descended the ocean river, till the responses were echoed from the cliffs of Quebec. . . . As the summons hurried to the south, it was one day at New York; in one more at Philadelphia; the next it lighted a watch fire at Baltimore; thence it waked an answer at Annapolis. Crossing the Potomac near Mount Vernon, it was sent forward without a halt to Williamsburg. It traversed the Dismal Swamp to Nansemond along the route of the first emigrants to North Carolina. It moved onward and still onward through boundless forests of pines to Newburn and to Wilmington. . . . Patriots of South Carolina caught up its tones at the border, and despatched it to Charleston, and through moss-clad live oaks and palmettoes still farther to the south, till it resounded among the New England settlements beyond the Savannah. . . . Ever renewing its strength, powerful enough even to create a commonwealth, it breathed its inspiring word to the first settlers of Kentucky; so that hunters, who made their halt in the matchless valley of the Elkhorn, commemorated the nineteenth day of April by naming their encampment LEXINGTON.

"With one impulse, the colonies sprang to arms; with one spirit, they

pledged themselves to each other 'to be ready for the extreme event.' With one heart, the continent cried, 'Liberty or Death.'"

Of the contentions of the Declaration of Independence, Bancroft comments:

"This immortal state paper was 'the genuine effusion of the soul of the country at that time, the revelation of its mind, when, in its youth, its enthusiasm, its sublime confronting of danger, it rose to the highest creative powers of which man is capable. The bill of rights which it promulgates is of rights that are older than human institutions, and spring from the eternal justice. Two political theories divided the world: one founded the commonwealth on the advantage of the state, the policy of expediency, the other on the immutable principles of morals; the new republic, as it took its place among the powers of the world, proclaimed its faith in the truth and reality and unchangeableness of freedom, virtue, and right. The heart of Jefferson in writing the declaration, and of Congress in adopting it, beat for all humanity; the assertion of right was made for the entire world of mankind and all coming generations, without any exception whatever; for the proposition which admits of exceptions can never be self-evident. As it was put forth in the name of the ascendant people of that time, it was sure to make the circuit of the world, passing everywhere through the despotic countries of Europe; and the astonished nations, as they read that all men are created equal, started out of their lethargy, like those who have been exiles from childhood, when they suddenly hear the dimly remembered accents of their mother tongue." [1]

What does Andrews think about this course of events? Discussing the Stamp Act and the requirement that the tax be paid in hard money, Andrews says:

"Two aspects of these laws are worthy of careful consideration. First, the financial aspect, to which little attention has hitherto been paid, though it had much to do with the hostility of the colonists to the measure. That which aroused apprehension in the colonies and created unrest was, in the beginning at least, the effect of the laws on the cost of living, their interference with the trade both at home and abroad, and their consequent menace to colonial prosperity. I venture to think that the mass of the colonial population bothered themselves but little with the intricate and subtle question of parliament's right to legislate for them, until that legislation touched intimately the daily condition of their lives. It is true that the question of 'right' had become at this time a subject of more or less legal and metaphysical speculation, for one finds among the resolutions of the Stamp Act Congress certain philosophical declarations regarding the inherent rights of man. But these speculations, as well as the reasoned arguments and vigorous utterances of contemporary writers of a legal and meditative turn of

[1] Bancroft, *History of the United States*, iv, pp. 160, 167f, 450. Reprinted by permission of D. Appleton and Co.

mind—such as Otis, Hopkins, Dulaney, and Dickinson—were of interest chiefly to intellectual circles. Newspapers and pamphlets had no widespread publicity, were limited as sources of news, and were inclined to controversy that often was long, verbose, and involved. The proceedings of the Stamp Act Congress itself, emblazoned as they are on the pages of history, passed almost unnoticed at the time, and there is nothing to show that the somewhat precise and finely spun reasoning of these intellectual leaders had any marked influence on the popular mind.

"Thousands of the colonists never passed beyond the point of objecting to these acts because they seemed contrary to the fundamental laws of reason and justice, but agitators and propagandists, such as Samuel Adams, Christopher Gadsden, and others, who were searching for reasons wherewith to justify resistance, pushed the argument to its logical conclusion and often were able to use the results of their reasoning with telling effect upon a people already aggrieved and fearful of worse things to come. . . . Many of the points at issue in their logical and philosophical form were beyond the mental range of the colonists—even in New England, where the average intelligence was higher than elsewhere; but money and the means of subsistence were matters that concerned all and touched the lives of the poorest and most ignorant. The dislike which the colonists felt for the Stamp Act and the Townshend Act was due to their fear, as one address puts it, of being compelled 'to give (Englishmen) our money, as oft and in what quantity they please to demand it,' and as Count Fersen said, in a moment of exasperation at the way the New Englanders fleeced the French soldiers, 'money was the prime mover of all their actions.' Once let the colonists believe that they were being unjustly treated by laws, whether of their own making or not, which threatened to drain them of what little circulating cash they had, and they were easily persuaded that these laws were not only ill advised but even unconstitutional. From this point it was but a short step to the conviction that Parliament at any rate had no right to tax them at all, because in so doing it was encroaching on the lawmaking powers of their own assemblies. Hence the eventual cry of illegality and unconstitutionality.

"In the second place, the Stamp Act and the Townshend Act were objectionable particularly because of their effect on the balance of trade with Great Britain. A stamp tax on legal and other documents and an import duty on glass, paper, and other commodities, would, if successfully collected, drain the colonies of their silver, and by just so much prevent the colonial merchants and planters from using this money to meet their trade balances. As early as January, 1764, Rhode Island had said, that should the Sugar Act be enforced 'there is not so large a sum of silver and gold circulating in the colony, as the duty imposed by the aforesaid act upon foreign molasses would amount to in one year, which makes it absolutely impossible for the importers to pay it.' . . . The British merchant was always worried about

the collection of his debts in America, and in a large majority of cases the colonial debtor was constantly struggling to square his accounts with Great Britain; while the pressure which the English or Scottish creditor brought to bear upon the merchant or planter in the colonies was passed on by the latter to the everyday man—the small householder, retail dealer, country storekeeper, farmer, and poor man generally—who bought on credit and was in a chronic state of arrears. Owing to the scarcity of hard money in the colonies and the tendency of paper to depreciate, the incurring of indebtedness was a prevailing habit with the colonists and suits for debt were matters of common occurrence. The situation became even more distressing after 1763, owing to the heavy obligations incurred in consequence of the war with France."

After the repeal of the Stamp Act:

"From the time of the Stamp Act to the end of the year 1773—eight years—the moderates were in the saddle, able to control the movement and hold the radicals in check. . . .

"At this critical juncture (1773), probably with the best of intentions and with no realization of the ultimate consequences, Lord North and his cabinet committed an irretrievable blunder. [The tea monopoly given to the East India Company.]

"For the first time an issue had arisen which affected moderates and radicals alike. The colonial merchants saw ruin staring them in the face, for not only were they threatened with the loss of their profits on tea, but were confronted also with the probability that the same company or other companies would be granted monopolies in such commodities as silks, drugs, and spices, all of which were essential articles in colonial life. They feared, as one of them wrote, that should this be the outcome, 'America would be prostrate before a monster that may be able to destroy every branch of our commerce, drain us of all our property, and wantonly leave us to perish by thousands.' The conservative merchants and the radical Sons of Liberty now found themselves linked together in a common cause. The monopoly of the East India Company threatened the business of the one, as the threepence a pound duty, which was still retained, threatened as 'tribute' the 'liberty' of the other; and both were facing what they believed to be a common danger, bondage to a power outside themselves. . . .

"The radicals scored their first victory and lessened the chances for reconciliation on December 16, 1773, when they destroyed £10,000 worth of the East India Company's property in Boston Harbor. This famous episode, known as the Boston Tea Party, was a spectacular performance, which in its wanton violation of private property found its equal elsewhere only in the burning of the *Peggy Stewart* in Annapolis harbor, an even less commendable affair, because thereby not only the company's tea was destroyed, but

the consignee's ship as well. . . . The crisis which had been averted for ten years was now come without hope of evasion." [1]

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[1] Andrews, selections from pp. 121-159. Reprinted by permission of Yale University Press.

## CHAPTER EIGHTEEN

# THE THINKING OF THE METAPHYSICIAN

Difficulties arising from the uniqueness of the universe

THE universe, considered as a whole, is but a single thing. There is nothing outside of it with which it can be compared. Accordingly, we must recognize at the outset that it constitutes an absolutely unique and induplicable object of study. It follows at once that laws describing its nature of the sort established by the scientist about recurrent events within the universe are entirely out of the question. If there were several universes, we could abstract and formulate the common elements in their behavior, and thus say something about them in the form of scientific law, but since there is only one this method of approach is quite impossible. Philosophers, therefore, who make it their venturesome business to pronounce on the nature of the universe as a whole, are logically in much the same situation as the historian; they are attempting to interpret an essentially unique event in its irreducible totality. But the historian's perplexity is probably not quite as severe as that of the metaphysician, for he can always find temporally distinct events that are like the immediate object of his investigation in many of their important details; he is thereby given a clue in what general direction to turn for the more significant forces that must play a part in his explanation, and he will find some science, such as sociology, that has abstracted laws from these similarities and is able to furnish concepts that are fairly definite and obviously applicable to aid him. The metaphysician is without even these meager advantages. The only thing to which he can compare the universe is something inside of it, and there are very many different kinds of things inside of it. There are minds and bodies, organisms and electrons, individuals and rela-

tions, change and eternity, subject and object, good and bad, beauty and ugliness, heaven and earth, time and space, the spiritual and the carnal, law and chance, love and hate, experience and beyond experience—to mention only a handful of the kinds of things that are bandied about in the discussions of philosophers. How shall anyone select from this confusing welter something which can be demonstrated objectively to be more characteristic of the universe as a whole than anything else, so that he may then parade before us as an assured result that the universe is experience, or an eternal mind, or a process of change, or a field of electrons, or a spiritual purpose, or perhaps a mere word? And to what standard shall he appeal when he attempts to answer the speculations of others who reject his selection and pick out some different entity as the key to the nature of the whole? Where is the accepted logic to which he may turn for final confirmation of his interpretation?

Resulting contrast with scientific thinking

Most metaphysicians in the past were prone to suppose that their enterprise was logically of the same character as that of the scientist. It appealed ultimately to objective facts, just as science did, though the facts might be of a different and more baffling sort; the two could in general rest upon a common method and criterion. But the facts that no two philosophical interpretations of the universe are in identical terms, and that the same old schools continue to war about the same basic issues, and that while in each century some agreements are reached, new issues appear which divide thinkers into hostile camps, suggest that we are dealing with a situation in which, try our best, we are unable to gain the objectivity of science. If we contrast the enterprise of the metaphysical philosopher with a bit of specific scientific inquiry, we shall find plenty of evidence to strengthen this suggestion.

When a layman falls ill with a malady which he has never had before, nor observed in anyone of his acquaintance, is it not quite impossible for him to give any intelligent guess as to which of his symptoms are particularly valuable for the diagnosis of his disease? Having had no really comparable experience before, his interpretative efforts are helpless, and it is only

the skilled physician, who is fortified by the accumulated and organized knowledge about similar sets of symptoms, who can select with confidence which among the phenomena present are significant. This point need not be labored, for in our early chapters it was amply illustrated. But if, without any such support from a comparative knowledge of the behavior of similar cases, such a patient should be impelled to attempt an explanation of his plight, how would he go about it to reach such an explanation?

The influence of personal emotion will not be fully controlled

Well established psychological principles, such as were summarized briefly in chapter three, afford a pretty definite answer to this question. He would make central in his interpretation those symptoms which most persistently attracted his attention, which in this case would mean those that were most continuously or intensely painful. Let us relate the situation more specifically to the factors of advantage in the association of ideas. Since the disease as a whole is recognized as novel, the law of frequency can play little or no part. Since he has not yet discovered a remedy, the law of effect is likewise impotent. (So far as there are similarities between this experience and others, these principles will, of course, not be eliminated entirely, but in his effort to understand the present ailment in its unique character they can give little help.) Accordingly, the other two laws, those of vividness and recency, will control his thinking with little check. This means that those phases of the experience which are most emotionally poignant and continuous will inevitably become central in his attempted explanation—his attention will be irresistibly attracted to them, and since he has had no experience of other cases of the same disease there will be nothing to correct this inevitable attraction by other considerations. He will be in the position of the first believers in the superstition that thirteen is an unlucky number, accepting it upon the tragic emotional concomitant of some experience in which the number played a part, but he will be without the fund of contradictory experiences which gave opportunity to the more intelligent to reject such a superstition. We always, in short, in every effort to explain phe-

nomena, accept as valid the first hypothesis which attracts our interest and attention, that proves able to conform to whatever further tests experience has taught us must be met. Since in this case such further tests are not yet applicable, the phases of the event which have unique and peremptory value for us as shown in their spontaneous attraction of our interest must become the central phases in our attempted explanation. In other words, let us see how far our guiding supposition in this entire section will help us understand the terrifying ambiguities of metaphysics.

**How this reveals itself in metaphysical thinking**

In many respects, of course, the above situation is not paralleled by that in which the philosopher finds himself, but in respect to the central lesson which we wish to draw do not the astonishing divergences of opinion about the world which one finds on the pages of philosophers strongly suggest that the parallel is real? Their thinking is continually disciplined, of course, by enlarging experience, which teaches them that certain concepts are not as pervasive or fruitful as they had once supposed them to be, none the less those factors of experience which do seem to be practically universal or can be interpreted as such are many. Accordingly, granted a preliminary difference in metaphysicians as to which of these general aspects of the universe shall first strongly arouse their interest and become the core of their attempted explanations, and the concept of this aspect, whichever it may be, often will be quite able to remain permanently in a given philosopher's thinking as the main key to the puzzle of the ultimate structure of reality. Recognizing the facts which his opponent quite otherwise accounts for, he yet finds it possible, by a little stretch of meanings, to bring them under his preferred scheme of interpretation, and to remain empirically faithful while still adhering to the general assumptions which first brought the entire panorama of existence into a harmonious order in his mind. In short, inasmuch as the universe is only one, the philosopher cannot check up his hypotheses by an experimental comparison of instances, as the scientist does, and thus objectify his guiding concept and the technique necessary to verify it. We may express the same

thing by saying that he is in the position of one whose hypotheses can never fully be either confirmed or rejected in any overtly demonstrable way; they continually float in solution in the thinking of generation after generation of inquirers, ever corrected and enlarged by the current of experience, but never either purged of their character as value which first gave them attracting power as possible solutions of the world-puzzle, nor rendered objective as regards their precise connotation or the degree of their validity.

This is to suggest that the great concepts of philosophical explanation are essentially value-concepts rather than fact-concepts—we see that they, like all concepts, must originate in thinking as the former, and it is difficult to see how they can ever be made the latter. If one man holds that mind is a form of matter because thinking always has material content and material conditions, while another maintains that matter is a form of mind because it never presents itself save as the object of conscious activity, it becomes pretty evident that these terms are not merely descriptive of denotable objects. They represent valuations, in that one thinker prefers to read primary and comprehensive meaning into the concept of matter and make mind a derivative and subordinate concept, while the other's preference is just the reverse. Since the nature of the facts involved and the historical use of these terms is what it is, who can clearly and objectively refute the assertions of either? Where shall we find a standard which can be made acceptable to both?

**Illustrated by the issue between Spinoza and Hume**

We may helpfully illustrate these points by considering briefly two modern philosophers who can be subordinated to no others in keenness of intellectual power, but whose fundamental doctrines are almost diametrically opposed, Spinoza and David Hume. The former places at the very foundation of his metaphysical system the conception of a self-caused being, which the latter believes himself to demonstrate to be entirely without meaning and validity.

Both were men whose interests were predominantly practical, but the practicality was of two very different types. Spinoza's profound urge was for salvation, for the complete victory over

passion, and the control of his entire life by a good which transcends all sceptical criticism by reason of being single, all-embracing, and final. Such an urge was as foreign to Hume as anything well could be. His interests were varied—none was very deep, nor did he feel any vital need to unify them. So far as they were brought together under a single controlling motive, the latter was something far removed both from the religious cry for salvation and from the metaphysician's passion for absolute and certain knowledge—it was the interest of the literateur in developing an effective style and winning a reputation in the field of letters. Do these divergences of fundamental interest help to explain the radical differences of their conclusions? Let us see.

**Spinoza's statement**

After experience had taught me [says Spinoza], that all the usual surroundings of social life are vain and futile; seeing that none of the objects of my fears contained in themselves anything either good or bad, except in so far as the mind is affected by them, I finally resolved to inquire whether there might be some real good having power to communicate itself, which would affect the mind singly to the exclusion of all else: whether, in fact, there might be anything of which the discovery and attainment would enable me to enjoy continuous, supreme, and unending happiness. . . .

All the objects pursued by the multitude not only bring no remedy that tends to preserve our being, but even act as hindrances, causing the death not seldom of those who possess them, and always of those who are possessed by them. There are many examples of men who have suffered persecution even to death for the sake of their riches, and of men who in pursuit of wealth have exposed themselves to so many dangers, that they have paid away their life as a penalty for their folly. Examples are no less numerous of men, who have endured the utmost wretchedness for the sake of gaining or preserving their reputation. Lastly, there are innumerable cases of men, who have hastened their death through over-indulgence in sensual pleasure. All these evils seem to have arisen from the fact, that happiness or unhappiness is made wholly to depend on the quality of the object which we love. When a thing is not loved, no quarrels will arise concerning it—no sadness will be felt if it perishes—no envy if it is possessed by another—no fear, no hatred, in short no disturbances of the mind. All these arise from the love of what is perishable, such as the objects already mentioned. But love towards a thing eternal and infinite feeds the mind wholly with joy, and is itself unmingled with any sadness, wherefore it is greatly to be desired and sought for with all our strength. . . .

I will here only briefly state what I mean by true good, and also what is the nature of the highest good. In order that this may be rightly under-

stood, we must bear in mind that the terms good and evil are only applied relatively, so that the same thing may be called both good and bad, according to the relations in view, in the same way as it may be called perfect or imperfect. Nothing regarded in its own nature can be called perfect or imperfect; especially when we are aware that all things which come to pass, come to pass according to the eternal order and fixed laws of nature. However, human weakness cannot attain to this order in its own thoughts, but meanwhile man conceives a human character much more stable than his own, and sees that there is no reason why he should not himself acquire such a character. Thus he is led to seek for means which will bring him to this pitch of perfection, and calls everything which will serve as such means a true good. The chief good is that he should arrive, together with other individuals if possible, at the possession of the aforesaid character. What that character is we shall show in due time, namely, that it is the knowledge of the union existing between the mind and the whole of nature. This, then, is the end for which I strive, to attain to such a character myself, and to endeavor that many should attain to it with me.[1]

Manner in which knowledge controls emotion

But how is it now that such knowledge of the entire realm of nature and of the mind's union with it may be expected to open the door to salvation? The fundamental observations by which Spinoza was led to this answer seem to have been the following. The essential character of the plight from which we long to be rescued is the fact that we find ourselves moved to love and pursue objects which keep disappointing our desire because their appeal is fickle and transitory, such as sensual pleasure, wealth, and fame. Repeated experiences of their fickleness lead us to generalize—if we could only find an object of love that carries an intrinsic and eternal appeal, the key to salvation would be found. But knowledge, and knowledge only, clearly leads in the direction of such an object, and gradually reveals it to us. We may see how it does so by contrasting the situation in which we are blindly controlled by a powerful emotion and that in which knowledge of the emotion, its causes and effects, is present to guide it. In the former case there is present to our attention only a very limited and temporary good—limited because it is merely the object of the emotion itself; temporary because as soon as that particular emotion is exhausted the appeal will be gone. In the latter case a larger

[1] Spinoza, *On the Improvement of the Understanding,* p. 1ff., published by George Bell and Sons.

and more stable good has appeared. It is larger because the total object of attention now includes the causes and effects of the emotion as well as the emotion itself; it is more stable because the relations of an event which emerge in our knowledge of it are the exact, regular, and dependable ones—this is, in fact, just what a causal relation means—whereas, as we have seen, the relation between an emotion and its primary object is capricious and variable. With every attainment of true knowledge, therefore, a good reveals itself to us which in the long run is more satisfying than the good upon which it supervenes. At first, of course, it lacks the intensity of the former's appeal, but by reason of its greater stability it is able to continue to attract at times when the former has lost its attracting power—accordingly, because of our fundamental demand for a good that does not disappoint, it is able gradually to wean us away from the control of the former, it steadily waxes in the degree of interest which it has for us, and consequently in its motive power over our conduct, whereas by the same token the former is playing a continually losing game. Now the causes and effects of any given emotion have of course, in turn, their own causes and effects. In order to understand the emotion with complete and perfect knowledge we need to reduce these also to a determinate logical order. Where will this expansion of knowledge and understanding reach its limit? Obviously only when we have grasped the essential nature of the entire panorama of events as a single necessary system of causal relations—true knowledge of the smallest fact involves knowledge of the whole universe of which it is a part, and from whose nature we must conceive it as flowing according to absolute and necessary law, precisely as it flows from the nature of the triangle that its three angles are equal to two right angles. Tennyson's oft-quoted "Flower in the Crannied Wall" is a poetic expression of the same thought which Spinoza was developing here:

> Flower in the crannied wall,
> I pluck you out of the crannies;—
> Hold you here, root and all, in my hand,
> Little flower—but if I could understand

What you are, root and all, and all in all,
I should know what God and man is.

Resulting conception of the universe

As we thus generalize from the experience of partial knowledge and partial salvation we are led inevitably to the conception of a whole of things, knowledge of which constitutes absolute and final knowledge. By the same token this absolute whole becomes the final and supreme object of desire, of love. Being absolute and all-inclusive, it is eternal and can never disappoint in the nature of the case. Because it is the ultimate cause of all things, the conception of it becomes associated more and more indissolubly with everything else to which our attention is attracted; accordingly, while at first its power to win our love is pale and feeble, it continually increases in intensity at the expense of all lesser objects of desire. Being thus the supreme object of love as well as of knowledge—that in love of which we are saved from our bondage to the emotions—this absolute and all-inclusive whole becomes not merely substance or universe, but God. The religious category cannot be denied it.

We may thus readily conceive the power which clear and distinct knowledge . . . founded on the actual knowledge of God, possesses over the emotions; if it does not absolutely destroy them, in so far as they are passions, at any rate it causes them to occupy a very small part of the mind. Further, it begets a love towards a thing immutable and eternal, whereof we may really enter into possession; neither can it be defiled with those faults which enter into ordinary love; but it may grow from strength to strength, and may engross the greater part of the mind, and deeply penetrate it.[1]

How far this result conditioned by Spinoza's interest

Now whatever may be our opinion with reference to the validity of this answer to the great problems of metaphysics —this conception of the universe as a determinate and unified order of logical relations from which absolutely everything that happens, including our emotions, purposes, and ideas, flows with unalterable geometrical necessity—it is surely difficult to suppose that Spinoza would have reached the doctrine, at least in just this form, had his controlling interest in philosophy been quite different from what it was. Is not this absolute necessary substance fundamentally the reflection of his demand for a

[1] Spinoza, *Works* (Elwes Edition), II, 258.

final, dependable good, disciplined and chastened, of course, in the form it takes, by loyalty to fact and scientific method, but none the less finding the ultimate significance and meaning of fact in a way which he would never have been apt to pursue had his guiding urge been different. The universe he discovers is the universe he most deeply wants, in so far as his want is not entirely negated when brought up against the objectivity of fact. For how else can we think in metaphysics?

**Hume's problem**

But it is this notion of an all-inclusive substance, absolute and eternal, which is both the cause of its own existence and of the existence of all of its infinite parts, that Hume thinks his philosophy shows to be quite impossible.

The philosophy of Hume's predecessor, Locke, had run into a snag, due to the fact that his empirical method of analyzing knowledge had led him to define it solely in terms of our ideas, while his acceptance of the current metaphysical dualism of mind and matter involved the belief that our ideas existed inside of our brains and had no direct contact with the outside world. How then can we know that our ideas correspond to the external material realities which they are supposed somehow to represent? Berkeley, a redoubtable bishop, seized upon the opportunity offered by this puzzle to deny that there were any such external material things—the world for him is composed merely of minds and their ideas—that is, the sense-data which constitute their immediate object. Now Hume was impressed by the fact that while nobody was able really to refute Berkeley's philosophy, nevertheless nobody seriously believed it. People went on thinking and acting on the common-sense assumption of an external non-mental world. Though Berkeley wrote his books, he says, against sceptics as well as atheists and free-thinkers, they are really themselves sceptical, "for they admit of no answer and produce no conviction." [1] Here was surely a strange and interesting situation.

Moreover, Hume had a keen speculative mind himself, when he felt like exercising it, and he soon observed that by pursuing

[1] Hume, *Enquiry Concerning the Human Understanding* (Open Court Edition), p. 164.

The sceptical result reached

Locke's empirical method still more consistently than Berkeley had done, somewhat more distressing results would be reached than those arrived at by the good bishop. The notion of a mind, or spiritual substance, was quite as impossible as the notion of an external material substance. For,

> when I enter most intimately into what I call myself, I always stumble on some particular perception or other, of heat or cold, light or shade, love or hatred, pain or pleasure. I never can catch myself at any time without a perception, and never can observe anything but the perception. When my perceptions are removed for any time, as by sound sleep, so long am I insensible of myself, and may truly be said not to exist. . . . If anyone, upon serious and unprejudiced reflection, thinks he has a different notion of himself, I must confess I can reason no longer with him. All I can allow him is, that he may be in the right as well as I, and that we are essentially different in this particular. He may, perhaps, perceive something simple and continued, which he calls himself; though I am certain there is no such principle in me. But setting aside some metaphysicians of this kind, I may venture to affirm of the rest of mankind, that they are nothing but a bundle or collection of different perceptions, which succeed each other with an inconceivable rapidity, and are in a perpetual flux and movement.[1]

Likewise, Hume maintains, the notion of an absolutely necessary and dependable causal relation vanishes very quickly when we subject it to criticism by the same empirical method. Take any case of a supposedly necessary relation of this kind, such as that between the eating of food and the cessation of hunger. All that we empirically know is that the eating precedes the cessation of hunger, is contiguous with it, and has uniformly, so far as our memory goes, been followed by it. But how can we be sure that it will be followed by it in the future? If we are not sure, the relation is not absolute, and the supposed knowledge degenerates into probability. Now when we ask how we come to believe as strongly as we do that the future will resemble the past in these causal relations, we see that the relation cannot possibly be absolute for our knowledge, and accordingly that the supposed necessity and certainty were illusory. The uniform connection of cause and effect in our past experience has formed an indissoluble association between the two in our thinking, so that when we see the cause we can-

[1] Hume, *Treatise of Human Nature* (Everyman Edition), I, 239.

not help expecting the effect with complete confidence; our imagination passes from one to the other without the slightest restraint from contrary associations. The necessity, therefore, lies in us rather than in the objects, and it does not lie in our reason (for that could never be able to tell us that an event which has always in the past been followed by a certain other event must continue to be followed by it in the future, the future not yet having entered experience or become subject to knowledge), but simply in the irrational feeling of liveliness and vigor with which the two events are bound together in our imagination.

The kind of knowledge then possible, and its relation to practice

The attempt, therefore, to answer such questions as: Are there necessary causal relations? Do independent external substances exist? Is there such a thing as a unitary mind? is quite a forlorn attempt; it presupposes that we can transcend an experience which as given is obviously fragmentary. Reason, operating merely on the empirical data, can find no justification for completing it in the direction of one answer rather than another. As given us, things are quite loose and disjointed, and reason, if it adhered simply to fact, would find itself plunged in hopeless scepticism when it tried to deal with any of these metaphysical questions. The most interesting question which it can hope to answer is the psychological one—why is it that we find ourselves so irresistibly moved to believe a certain answer to these questions, even though we can give no logical justification for the answer in terms of experience and reason? And to answer this Hume appeals to feeling and imagination operating on habits built up in past experience, as the above illustration indicates.

Fortunately, however, the sceptical paralysis into which reason falls when it tries to consider frankly this anomalous situation, cannot long be maintained. There is no escape from it when the speculative mood is in control, but the philosopher needs to eat and drink, walk and converse like other people, and as soon as he engages in these activities he finds himself assuming permanent minds, an external world, and the like, just as the rest of mankind do. His life, accordingly, becomes a per-

petual oscillation between periods of practical activity, when he is controlled by an imagination which cannot logically justify itself, and which, therefore, tends to arouse sceptical questionings as soon as reason is rested, and periods of speculative endeavor, which destroy themselves erelong by their hopelessness and by the gradual inrush of other insistent needs of human nature.

Most fortunately, it happens, that since reason is incapable of dispelling these clouds, Nature herself suffices to that purpose, and cures me of this philosophical melancholy and delirium, either by relaxing this bent of mind, or by some avocation, and lively impression of my senses, which obliterate all these chimeras. I dine, I play a game of backgammon, I converse, and am merry with my friends; and when, after three or four hours' amusement, I would return to these speculations, they appear so cold, and strained, and ridiculous, that I cannot find it in my heart to enter into them any further.

Here, then, I find myself absolutely and necessarily determined to live, and talk, and act like other people in the common affairs of life. . . . I may, nay, I must, yield to the current of nature, in submitting to my senses and understanding; and in this blind submission I show most perfectly my sceptical disposition and principles. But does it follow that I must strive against the current of nature, which leads me to indolence and pleasure; that I must seclude myself, in some measure, from the commerce and society of men, which is so agreeable; and that I must torture my brain with subtilties and sophistries, at the very time that I cannot satisfy myself concerning the reasonableness of so painful an undertaking, nor have any tolerable prospect of arriving by its means at truth and certainty? Under what obligation do I lie of making such an abuse of time? And to what end can it serve, either for the service of mankind, or for my own private interest? No; if I must be a fool, as all those who reason or believe anything certainly are, my follies shall at least be natural and agreeable. Where I strive against my inclination, I shall have a good reason for my resistance; and will no more be led a wandering into such dreary solitudes, and rough passages, as I have hitherto met with.

These are the sentiments of my spleen and indolence, and indeed I must confess, that philosophy has nothing to oppose to them, and expects a victory more from the return of a serious, good-humored disposition, than from the force of reason and conviction. In all the incidents of life, we ought still to preserve our scepticism. If we believe that fire warms, or water refreshes, it is only because it causes us too much pains to think otherwise. Nay, if we are philosophers, it ought to be only upon sceptical principles, and from an inclination which we feel to the employing ourselves after that manner. Where reason is lively, and mixes itself with some propensity, it

ought to be assented to. Where it does not, it never can have any title to operate upon us.

At the time, therefore, that I am tired with amusement and company, and have indulged a reverie in my chamber, or in a solitary walk by the river side, I feel my mind all collected within itself, and am naturally inclined to carry my view into all those subjects about which I have met with so many disputes in the course of my reading and conversation.[1]

Surely a rather different outcome from that reached by Spinoza! Here it appears that not only can we establish no justifiable conception of the universe as a single, objectively real entity, determining by its nature, in accordance with absolute law, all that happens within it; but even the less inclusive unities of physical bodies, minds, and causal complexes, disintegrate before the doubts of reason, and our supposed knowledge about them reduces to a very dubious probability. What brought Hume to this result? It will hardly do to say merely that the facts forced it upon him. Some of his successors, in full recognition of these facts, and of his interpretation of them, developed a scheme of the universe as absolutistic and rationalistic as that of Spinoza. What is the fundamental explanation of this sceptical portrayal?

How far illuminated by Hume's interest

We certainly find some illumination on this point when we study the basic interests of the man; indeed, the passage above quoted gives significant hints here. Hume was obviously, despite his metaphysical keenness, no passionate seeker after ultimate truth. He rather enjoyed the unresolved inconsistencies of his scepticism; he felt no compelling urge, either to conform life to reason, or to correct logic by life. He took a quizzical pride in the startling contradictions which he left with his readers, knowing full well that none of them would be able to refute him entirely, and that most would treat his philosophy exactly as they did that of Berkeley. His strongest interest, as he himself confesses in his *Autobiography*, was in attaining fame in literature. A sceptical metaphysic would be as serviceable to this end, if skillfully developed, as an absolute monism—perhaps more so. At any rate, it would compare favorably, in the state of literary interest in England in his day, with essays

[1] *Ibid.*, 254f.

on history, psychology, economics, and morals, about which he also wrote in the same clear and entertaining style. Philosophy for Hume was fundamentally, like these other subjects, a medium for clever discussion, an instrument for the attainment of a literary reputation. Can we suppose for a minute that had this purpose been less prominent, and had Hume been dominated by the consuming passion for consistency of an Aquinas or a Hegel, he would have left with his readers such a disjointed and irrational universe as this?

Which of these two philosophies is nearer the truth than the other? Both of them can hardly be true, if truth means anything in speculations of this kind at all. How can such a question be answered? How can we establish an objective standard, acceptable to all competent philosophers, by which we can test and measure contrasting doctrines, and definitely determine their validity or invalidity within a finite time? As yet it is clear that philosophy has discovered no such standard.

How can a standard for metaphysical thinking be established?

Our general assumption in this chapter—that philosophical thinking involves a process of evaluation—will not be accepted by all philosophers, for there is absolutely nothing upon which all philosophers are agreed, save perhaps the desirability of philosophizing itself. But if this assumption is correct, one important and positive point becomes clear, namely, that that philosophy is nearest the truth which most fully and appreciatively understands the valuations expressed in other philosophies, and includes them all, so far as possible, within its own valuation. But how is this to be done in such a way that the larger harmony of values attained in such a philosophy shall directly and objectively present itself as such to other philosophers, so that they shall recognize that in it their own philosophy finds its complete fulfillment?

Philosophy is an age-old enterprise of the human mind, and there is no indication that the craving for a synthetic understanding of the baffling totality within which we live and have our being, of which philosophy is the expression, is diminishing or likely to diminish. But what does correct thinking in philoso-

phy mean? Who can point out an acceptable standard for the testing of speculations on these ultimate problems?

EXERCISE.—Compare the convictions on the nature and criterion of truth expressed in James, *The Meaning of Truth*, with those affirmed in Bradley, *Essays on Truth and Reality*. Just what is the fundamental issue? What difficulties do you find in each position? How far do you think they appreciate each other's point of view? Do you see any way by which such positions can be reconciled?

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## CHAPTER NINETEEN

# PROBLEMS OF REFLECTION IN THE CREATION OF BEAUTY

Comparison of beauty with other types of value

THAT the experience of beauty involves a process of evaluation probably no one would deny. That which makes an object beautiful is in large part its spontaneous harmony with the conditions set by a certain kind of desire or interest in the beholder; the feeling of satisfaction which we experience in our admiring contemplation of the beautiful object is witness to the achievement of such harmony. But beauty has a uniqueness which clearly differentiates it from other types of value, and with this uniqueness are connected unique difficulties for right thinking in æsthetics.

When our attitude is that which we rather lamely term theoretical, as in the scientist's pursuit of truth, we are endeavoring, so far as in us lies, to conform our thinking and feeling to what is externally given, which we assume has a specific nature to be understood independent of the play of desire and interest in ourselves. We want to know, in short, what it really is, quite apart from anything else that we may propose to do about it. When our attitude is what we call practical, in its common-sense contrast to the term theoretical, the situation is reversed; we have an end of our own which we are striving to reach, and our relation to the concrete things with which we deal is one of bending them into conformity to a purpose which they would otherwise not serve. Instead of rendering our mental processes harmonious to what is happening in them we are harmonizing them to something which happens in us—they take the status of dependent means to our chosen end, so far as we can make them such.

The unique character of the beautiful object lies in the fact that it seems to offer a spontaneous, unsought harmony between our desire and the externally given. Without painful effort, such as is normally involved both in the earnest quest for truth and the active molding of means to our ends, something suddenly appears before us—a flower, a landscape, a majestic mountain peak, the heaving sea, a lovely face—in the appreciative perception of which we find, as it were, an unearned satisfaction, a joy emerging without precedent sorrow. Beauty is Nature's grace, the symbol of a superfluity of her goodness to the appreciative soul, affording a pleasure counterbalanced by no pain.

The beautiful is a spontaneously offered harmony between desire and fact

The extent to which our evaluating processes penetrate the æsthetic experience becomes evident if we examine for a moment a typical occasion on which we are surprised by the appearance of beauty and stand lost for a while in admiring absorption. We will discover that our attention, and indeed all our perceptive faculties, are alive and alert; that they pass and repass lovingly from one part of the object to another, finding renewed delight in each feature when we return to it enriched by the meaning of the other parts, until finally satiety comes upon the entire experience and other tasks engage our attention. What is the explanation of this active and continued play of perception over the beautiful object? At first sight it seems wholly different from the clarifying observations with which we invest a problematic situation and which have been analyzed in the earlier part of our discussion. Such observations are controlled by the definite need of eliciting by their aid a hypothesized solution of the problem; an explanation of it if it be a scientific problem, a way of controlling it for our immediate end if it be a practical problem. Suppose, however, we think of this æsthetic enjoyment as a process of the active determination of ends, in which, so to speak, the object both furnishes the stimulus for our thinking and coöperates with it for a time, continually offering in visible form the end we want as soon as that end gains clarity. In other words, let us view it as a process of valuation repeated over and over again, the separate steps in each unit almost telescoping in their rapidity, the key to the

The beautiful as external coöperation in our reflective determination of ends

nature of the whole lying in the fact that as our imagination is stimulated by our enjoyment of a part of the object to picture the larger whole which would satisfy more fully, it only needs to follow the play of attention to other parts of the object to see spread out before it exactly that desired whole. The conscious determination of our end is thus paralleled for a time by the revelation of that end in the scene spread out before us, so that even the features which first awakened attention are not exhausted by our preliminary valuation of them, but grow in satisfying meanings as we continually come back to them to help in objectifying the larger ends which the object provokes us to seek. If this in general be a correct analysis of the æsthetic experience, we may describe it as a piece of evaluation in which Nature and ourselves coöperate in a unique way, Nature in one and the same continued process provoking our thinking to reach out after a larger whole of imagined satisfaction and presenting that whole before it as a gracious and unearned reward.

There is an objective element in æsthetic appreciation

But now it is evident that in the experience of beauty there is something which we feel to be objective rather than subjective, social rather than individual. The famous proverb, *de gustibus non disputandum,* applies over a wide range of life, but not, we feel, in the realm of genuinely æsthetic enjoyment. If Jack Sprat could eat no fat and his wife could eat no lean, they would not, if they were intelligent folk, upbraid each other for revealing invalid tastes, for it is admitted by all that in these matters the distinction between correctness and incorrectness has no application. In fact, if, as is usual in such cases, there is not enough lean or fat to satisfy both, the difference of taste becomes highly fortunate; the world would surely be a greater scene of struggle and disappointment than it is now if men's taste in relation to members of the opposite sex, for example, were uniform. But when we say not merely, "I like this," but, "This is beautiful," we seem to be asserting something that is not a matter of individual preference, but of conformity to a universal standard. We claim the assent of others; we insist that they, too, ought to find the same delight

in the object which we ourselves have discovered. The feeling is social in some sense, which means that in some way the judgment of beauty can be tested by a norm, can be pronounced objectively correct or incorrect.

**Revealed in our confident æsthetic comparisons**

Our assumption that there is a realm of contemplative enjoyment in which this is so seems clearly supported by many interesting facts of experience. If I abhor sour pickles, of which my friend is peculiarly fond, we call it a matter of taste and end discussion, agreeing that in such things individual preferences have a clear title to reign. But if I announce that in my opinion "She's My Baby" is a more beautiful piece of music than Beethoven's Ninth Symphony, my friend will be apt to dispute the matter; he will be quite convinced that there is an objective standard of æsthetic judgment somewhere by which such opinions can be tested, and that in this case I could be convicted not only of bad taste, but of falsehood in the judgment thus expressed. And there is no question but that those who devote themselves seriously to the study and appreciation of any one of the fine arts do find something like a common standard emerging, however vague it may be at best, and to the unpracticed quite incomprehensible.

**What is the nature of the standard thus assumed?**

But what is this standard? How can we define it? Where can we locate it precisely? What gives us the right to claim the assent of others in these judgments of beauty, to believe that this feeling which the object arouses in me is of such a sort that were others brought into the presence of the object they would share it with me? It is clear that in these situations we assume that the relation between something objectively given and certain enjoyable feelings is a universal relation, and that we can tell in any given pleasurable experience whether it is of this sort or not. But how do we tell? What is the logic of our thinking when we compare one object of contemplative enjoyment with another of the same type and pronounce one more beautiful than the other? We speak of the *connoisseur* in matters of artistic production, and we think of him as an individual whose sincere interest and wide experience in a certain field of beauty gives his judgment more of a normative

character than that of the rest of us—we see that though such expert critics are not in absolute agreement, yet their judgment is far more coherent and unified than that of the mass of men—and this strongly suggests that if the rest of us were interested enough to acquire their range and depth of experience, we should find our tastes too accordant in general with theirs. How does the connoisseur discover the standard which seems thus to reveal itself in his matured judgment? What is the essential nature of the process of reflective criticism in the course of which that standard has emerged into what clarity it attains?

**The thinking of the artistic genius presents a still more challenging problem**

These puzzling questions become more challenging still when we try to examine the thinking of the artistic genius as, faced with the plastic materials which he loves to form, whether stone, clay, oils and canvas, musical notes, words and phrases, he seeks to objectify a profound emotion so that the world may share it. How is this creative, experimental thinking controlled? What justifies the artist's assurance that his work will find an audience who, in beholding it, will in some way think his thoughts after him and revel in the delight which the guiding idea has given him? In the elaboration of the vision which he transmutes into material form for the admiring contemplation of others, by what principles is this play of creative imagination guided, what makes him sure that this or that touch will add to or detract from the appeal of the final result?

**Divergent schools of æsthetic theory**

It must be admitted that logic has shown itself peculiarly impotent in the face of these difficulties. Philosophers who have tried to understand the intrinsic nature of beauty have rarely been creative artists themselves and not always even competent critics, while the greatest artistic geniuses have as a rule been the least able to give any clear statement as to how they achieved their marvelous results. For the most part we have been forced to appeal to a quite mysterious, indescribable power or skill in the mind of the genius, and so far as concerns attempted formulations of the criterion of beauty or the general principles which guide artistic performance, we see the same division into diverse schools and tendencies which has prevailed in other departments of philosophy. There is the

classical school, which appeals to the phrase "unity in variety" to describe the essential nature of beauty, opposed vigorously in the eighteenth century and later by the romanticists, who emphasize "expressiveness" as the main factor in the criterion. In more recent times still the general traditional tendency to idealize the content of artistic production has been challenged by the "realistic" tendency (which corresponds in art to a frank and radical empiricism in social science) to embody life as it is actually experienced in all its dirt and sordidness, with something of an extra emphasis on the unsavory side in order to be sure that illusory hopes and idealistic biases are quite banished. And today we are confronted by what is vaguely termed "modern" art, whose main characteristic is wholesale experimentation with effects which from traditional standpoints would be regarded as discordant and hopelessly bizarre, in the hope that by such experimentation novel clues might be uncovered as guides to different types of art in the future. Merely to state such general tendencies, in their very great vagueness of meaning and uncertainty of application, well illustrates the logical confusion in which we find ourselves in respect to this entire and most appealing realm of experience.

**Illustration of the logical problem from visual art**

Analyzed in terms of the expressive medium used, there are three main types of art. One consists of those arts which appeal to the eye through visual forms. Painting and sculpture are the most familiar of these, one utilizing oils and canvas as materials, the other clay or stone. Another comprises the art which appeals to the ear through simultaneous and successive tone-groupings—that is, music. The third subordinates both these modes of entrance to the ideas conveyed, which are much more definite than in the above types since they are given verbal form. Literature, as exemplified in poetry, the novel, and the drama, is the field of this type of art. We shall proceed to illustrate the logical problems of creative art by contrasting art-products drawn from each of these three types.

From visual art consider the two accompanying reproductions of well-known statues. Both pieces of sculpture are supposed to represent the same individual, one being the Saint-Gaudens

statue of Abraham Lincoln, the other the more recently completed Barnard statue of the Civil War President. The aspect of the contrast which will strike the reader most prominently is that which has been described above as the issue between idealism and realism in art. In the Saint-Gaudens statue we see every feature of the Great Emancipator's appearance and bearing idealized; the rugged strength, dignity, poise, and deep kindliness which are believed to have characterized the man are given direct embodiment in the statue, assuming the form which in virtue of our habits of idealizing imagery we feel they ought to take in order to be unequivocally themselves. In gazing at this representation of Lincoln we see before our eyes in direct visible form all that our admiring sentiment wants to picture, controlled, of course, so far as they go, by the available verbal and photographic descriptions. By contrast the Barnard statue is thoroughly realistic. The tendency to embody our idealizations in overt form is here rigidly suppressed; in fact, in order to be sure that no traces of insecure idealism are present, the sculptor has perhaps overemphasized the homeliness of Lincoln and portrayed a rather exaggerated carelessness in dress and slouchiness in posture. The effect of the statue, as of all æsthetic realism, is to force the beholder to correct any dubious sentimentalism by appeal to concrete fact in its empirical harshness, and to encourage a deeper penetration of the outward form in the search for the genuine symbols of the traits which we feel must qualify the man. Those who have been accustomed to give sentimentalism rather free rein in their habits of æsthetic contemplation are apt at first sight to feel that such a representation is a caricature of its object, a repulsive rather than a satisfying portrayal. But appreciation of the deeper motives of realism, of the values which it endeavors above all else to embody, leads at least to some revision of this preliminary dissatisfaction. We are bidden to incorporate in our æsthetic enjoyment a deeper respect for fact instead of making our appreciations a mode of escape from fact into a realm of sentimental fancy. In each mode of portrayal there is thus a genuinely æsthetic appeal, but the appeal is to different processes,

LINCOLN—BY ST. GAUDENS

LINCOLN—BY BARNARD

different basic attitudes in the beholder. Accordingly, the reflective problem arises as to the relative validity for the artistic purpose of these two modes of appeal and the elements of human character to which they severally are directed. Which of these two statues is likely to be more permanently satisfying as an artistic portrayal of Lincoln, and by what standard shall we answer such a question?

From literature

Our selections from literature will be confined to brief poems quoted in their entirety, since summaries of novels or dramas could hardly be adequate to bring out clearly the logical questions which now occupy us. The selections will aim not merely to carry on the consideration, under this new medium, of the issue between idealism and realism, but also to reveal to some extent the difference between art that conforms closely to the rules established by past successful appeals to enjoyment and which have thus become classic standards for artistic performance, and art which delights in breaking free from all these rules and experimenting in quite novel and untrammeled ways, requiring of the reader a flexibility of feeling and a continual reconstruction of his conceptions of measure and rhythm.

First consider two poetic expressions of the feeling of appreciative loyalty to the community to which one belongs. One is Tennyson's "National Song" to England.

> There is no land like England,
>   Where'er the light of day be;
> There are no hearts like English hearts,
>   Such hearts of oak as they be.
>
> There is no land like England,
>   Where'er the light of day be;
> There are no men like Englishmen,
>   So tall and bold as they be.
>
> CHORUS
>
> For the French the Pope may shrive 'em,
> For the devil a whit we heed 'em:
> As for the French, God speed 'em
>   Unto their hearts' desire,
> And the merry devil drive 'em
>   Through the water and the fire.

FULL CHORUS

Our glory is our freedom,
We lord it o'er the sea;
We are the sons of freedom,
We are free.

There is no land like England,
Where'er the light of day be;
There are no wives like English wives,
So fair and chaste as they be.

There is no land like England,
Where'er the light of day be;
There are no maids like English maids,
So beautiful as they be.

CHORUS, ETC.

The other is Carl Sandburg's poem "Chicago." [1]

Hog-butcher for the world,
Tool-maker, Stacker of wheat,
Player with Railroads and the Nation's Freight-handler;
Stormy, husky, brawling,
City of the Big Shoulders:
They tell me you are wicked and I believe them, for I have seen your painted women under the gas lamps luring the farm boys.
And they tell me you are crooked, and I answer: Yes, it is true I have seen the gunman kill and go free to kill again.
And they tell me you are brutal and my reply is: On the faces of women and children I have seen the marks of wanton hunger.
And having answered so I turn once more to those who sneer at this my city, and I give them back the sneer and say to them,
Come and show me another city with lifted head singing so proud to be alive and coarse and strong and cunning.
Flinging magnetic curses amid the toil of piling job on job, here is a tall bold slugger set vivid against the little soft cities;
Fierce as a dog with tongue lapping for action, cunning as a savage pitted against the wilderness,
Bareheaded,
Shoveling,
Wrecking,

[1] By permission of the publishers, Henry Holt and Co.

Planning,
Building, breaking, rebuilding,
Under the smoke, dust all over his mouth, laughing with white teeth,
Under the terrible burden of destiny laughing as a young man laughs,
Laughing even as an ignorant fighter laughs who has never lost a battle,
Bragging and laughing that under his wrist is the pulse, and under his ribs the heart of the people.
Laughing!
Laughing the stormy, husky, brawling laughter of youth; half-naked, sweating, proud to be Hog-butcher, Tool-maker, Stacker of Wheat, Player with Railroads, and Freight-handler to the Nation.

Analysis of the main differences

The former of these two poems we see filled with the sentimental boasts that patriotic expressions are wont to make of the object of their loyalty; the idealizing tendency is given free rein, and the swing of the accent and the rhyme is admirably adapted to set off this play of patriotic fervor. The latter, while of course not free from a certain impressionistic sentiment without which neither of these expressions would appeal to the sort of feeling to which they do appeal, carefully avoids sentimental falsehoods of the type characteristic of the former poem, and endeavors to pick out for appreciative enjoyment just those features of its object that an impartial comparison would be apt to stress were it to take the form of objective, prosaic description. In order to make these media of æsthetic satisfaction in spite of their naturally repellent aspects, the descriptive phrases are selected and arranged with minute care, so that the reader will feel otherwise ugly qualities hit off with such keen portrayal that they gather an æsthetic appeal in spite of themselves. The cumulative force with which the representation rides on to its vivid close adds not a little also to the same effect.

With these two poems before us we can see more fully the main æsthetic danger of these two tendencies in art, the idealistic and the realistic. The danger of idealism is that the artistic expression may rest upon modes of sentiment which, however deeply they are rooted in a given age or people, are not lasting, so that when the idealizing attitudes upon which they depend change, the power they have exerted will inevitably wane. If,

for example, the time should come when the boastful claims characteristic of Tennyson's poem are no longer felt generally to be in good taste, the piece would no longer be able to arouse the feeling it aims to produce. Our enjoyment of an otherwise captivating rhyme would be handicapped by distress at a mode of idealization which we had outgrown. Realism is in large part a definite effort to avoid this danger by enshrining in its portrayals a stronger respect for empirical fact, with even a tendency to exaggerate the distasteful qualities of its objects in order to be sure that idealizing sentiment is quite overcome. In doing this, however, it runs into another danger, namely that the harsher fact thus accepted will not be expressed with sufficient skill to furnish the contemplator with an unfailing stimulus to æsthetic satisfaction; the feeling which the realist actually rests upon may turn out to have been merely morbid curiosity or a fickle preoccupation with the gruesome. Which of these dangers is the more serious, and why?

But the reader will have noticed another important difference between these poems. This is in their poetic structure. Tennyson's poem conforms to all the rules for measure and rhyme which were generally accepted in the nineteenth century, and the diction, in spite of its simplicity, is intended to violate no standards of refinement. Sandburg's poem is completely free in these respects. So far as its versification is concerned, it stands entirely by itself. It follows no rule, and is not meant to become a model for any other poem to follow. The structure is individualized to fit the theme. For this reason some critics still refuse to admit the claim of such writing to be called poetry at all. Moreover, it is evident that the author did not allow himself to be hampered by any standards of elegance in diction. He is ready to use at all times the word that most directly and vividly expresses the fact he wishes to portray. He gains thus a living pertinence of style as against the cautious and classically molded phrases of Tennyson.

Another aspect of the contrast between these two opposing modes of æsthetic appeal will become clear if we examine two

other poems of the same authors. Consider the attitude toward death expressed in Tennyson's famous "Crossing the Bar."

A further corollary of realistic empiricism

Sunset and evening star,
And one clear call for me!
And may there be no moaning of the bar
When I put out to sea,
But such a tide as moving seems asleep,
Too full for sound and foam,
When that which drew from out the boundless deep
Turns again home.

Twilight and evening bell. . . .
And after that the dark!
And may there be no sadness of farewell
When I embark;
For, though from out our bourne of time and place
The flood may bear me far,
I hope to see my Pilot face to face
When I have crossed the bar.

Compare with the attitude expressed in Sandburg's "Cool Tombs."[1]

When Abraham Lincoln was shovelled into the tombs, he forgot the copperheads and the assassin . . . in the dust, in the cool tombs.

And Ulysses Grant lost all thought of con men and Wall Street, cash and collateral turned ashes . . . in the dust, in the cool tombs.

Pocahontas' body, lovely as a poplar, sweet as a red haw in November or a pawpaw in May—did she wonder? does she remember? . . . in the dust, in the cool tombs?

Take any streetful of people buying clothes and groceries, cheering a hero or throwing confetti and blowing tin horns. . . . Tell me if the lovers are losers. . . . Tell me if any get more than the lovers . . . in the dust . . . in the cool tombs.

The former of this pair of poems expresses serene faith in the convictions which promise full satisfaction to the religious aspirations which had become classic and habitual to people of the author's age and heritage. It thus enshrines in appealing imagery a trustful acquiescence in the standard beliefs respect-

[1] By permission of the publishers, Henry Holt and Co.

ing the limits of mystery within which human life is lived. It is a part of the general realistic tendency in art to distrust ready acquiescence in such convictions and the longings which they satisfy. Instead, realism is more ready to recognize frankly the extent of the mystery involved and to secure its æsthetic thrill in the unsatisfied wonder at what lies beyond. The note of doubting wonder replaces that of secure faith, and the hint is not lacking of a different standard of value for life as a corollary of the different attitude present. Again, how shall we tell in any objective way which attitude toward such mysterious matters offers the more dependable response to artistic creation?

Illustration of the problem from music

In music the contrast between such tendencies as those of idealism and realism loses most of its pertinence, because here there is no external object to which the artist must be faithful, and accordingly the question of degree of empirical appeal does not arise. The most striking divergence is apt to be one between rather close adherence to classical rules of harmonization and a freer, if not quite radical, experimentation with novel modes of tone-grouping. The accompanying selections from well-known compositions will be sufficient to exemplify this difference and bring out the meaning of our central problem as revealed in the field of music. The Brahms selection is conservative; it remains carefully within the limits set by principles generalized from past successes, merely attempting to offer as its theme a slightly different permutation of tone-relations than had before been developed. The Honneger selection by contrast is radical. It breaks away without compunction from the authority of such principles, seeking a quite free expression, within its chosen medium, of an emotional impulse. It appeals to the listener to develop a flexibility of appreciation, a readiness to take such an unconventional expression on its own terms and test it by its inherent purpose rather than by an external standard.

Summary of the chapter

Our questions with reference to the difficulty of establishing clear æsthetic standards have been offered in the course of discussing these illustrations, and need hardly be stated separ-

## PIÈCE POUR LE PIANO

Arthur Honneger.


A product of contemporary experimentalism. Notice how independent melodic lines are placed one above another, despite the resulting clashes. Reprinted with the permission of owners of copyright, Editions Maurice Senart, 20 Rue de Dragon, Paris.

## INTERMEZZO, OPUS 118, NO. 2

J. Brahms.


A good illustration of nineteenth century composition.

ately at the close. It is evident that in some sense the creative artist (and to a lesser degree the individual appreciatively enjoying his work) is facing a definitely reflective problem, that of the social objectification of a feeling individually prized. He who successfully grasps the requirements of such objectification implies æsthetic judgments that are definitely superior to those ventured by less successful minds, as making possible a larger attainment of the result that in the æsthetic enterprise is always sought. But what is the standard that determines this kind of success? How can we state in clear and precise form the nature of that beauty whose reality and objectivity we presuppose in every æsthetic experience, or in just what way, through a given medium, the fullest appreciative response may be won?

It may well be, of course, that it is impossible and undesirable to reduce the æsthetic consciousness entirely to a mechanical technique, that if such analysis were fully accomplished something uniquely valuable in this type of experience would have slipped away. Such a question the present chapter does not intend to prejudge. In fact, the reader will easily see that if the comments in chapter fourteen on the essential nature of valuation are on the right track, it would have to be admitted in general that this is the case. None the less it holds true that at every point in the experience of beauty where reflection enters, its function is precisely to establish and apply a standard, grasped as clearly and formulated for guidance as definitely as the nature of the case permits. The problem of right thinking in such matters is then no unreal problem. Where are the pioneers of logic who can begin the conquest of the field of artistic creation and appreciation?

Exercises.—A. Compare the portrayals of Venice offered by Monet and by Canale from almost the same spatial standpoint. What are the æsthetic assumptions of each?

B. Read Winston Churchill's *The Inside of the Cup* in comparison with Sinclair Lewis' *Elmer Gantry*. Abstract as fully as you can from the sociological problems involved, and consider the books purely in terms of their æsthetic appeal. On just what does the latter rest in each case?

C. Play in close succession the familiar wedding marches of Wagner and of Mendelssohn. What differences significant for logic do you note?

How far are they characteristic of differences between the two composers as revealed in other productions?

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## CHAPTER TWENTY

# HOW SHALL WE THINK IN RELIGION?

IN ALL the forms of religion that are of immediate concern to a reflective thinker we have an institution that promises to those who follow its prescriptions a way of salvation. What does salvation mean? For our present purpose it is sufficient to note that whatever else it means it includes the realization of one's ultimate at-homeness in the universe. It means a mode of life in which evil is transcended, so that the panorama of events, viewed as a single whole, presents itself as neither evil nor indifferent but good. To believe in God is, whatever else it involves, to have faith in a being whose existence is felt somehow to guarantee the final supremacy of good in the believer's experience. The existence of the world is justified as a drama which in the end is a divine comedy, not a tragedy; its net outcome is a value positive, inclusive, and deep. The universe, when seen through and through, harmonizes with our profounder valuations. As St. Paul remarks, "To those that love God all things work together for good"—in other words, God is the being whom to know and to love brings it about that all things which enter our experience shall be seen as means to an ultimate good. That religious thinking involves a fundamental element of evaluation is accordingly clearly evident.

The place of evaluation in religious

Before, however, we embark upon the larger problems suggested by this fact, a few preliminary discussions will not be out of place. Many who first take up the study of logic come from religious environments in which certain attitudes are apt to prevail such as logicians of all schools would so unanimously condemn that it seems silly not to recognize the fact and discuss these attitudes with complete frankness, attempting to show

Certain preliminary considerations—belief in miracles

clearly their inconsistency with the central assumptions of all careful, critical thinking. Accordingly, let us analyze the thinking revealed in certain beliefs which still exert widespread popular influence, beginning with the belief in miracles. For it is evident that many people believe quite firmly in the reality of occasional divine interferences with the ordinary course of events, providentially bringing about results that would not otherwise occur.

If we examine what goes on usually in our thinking when something extraordinary occurs in our experience, we find that we tend to assume that the occurrence has regular causes if we only knew how to locate them. When a friend who has been sick nigh to death suddenly and unexpectedly begins to improve, we suppose that changes in the physiological conditions adequate to account for the sudden improvement had taken place even before we saw overt evidence of them; and if our wish, on the morning of a long planned outing, that the day be clear is followed immediately by the dispersion of the clouds, we do not imagine that our wish replaced or affected the atmospheric conditions which normally produce fair weather. Now since we mean by a miracle (or ought to, if the term is to be given a consistent and important significance) a definite exception to or violation of such regular causal relationships, why should we ever be tempted to suppose its reality, and are there ever any conditions under which belief in its reality is legitimate?

**Hume's analysis of such beliefs**

The essential features of our answer to these questions are contained in the discussions of the first part of the present volume—it happens, however, that they are stated so forcibly in David Hume's famous essay *On Miracles* that we may appropriately turn to it for guidance. The former, or psychological, question as to the explanation of the belief in miracles, Hume answers in substance as follows. Since unusual events that happen in our own experience we do not ordinarily suppose to be miraculous, but view as instances of some regular causal law, however difficult to discover, it is evident that it is on the support of the testimony of others that we believe in the real occurrence of those miracles which we do accept, this testimony

usually gaining force for our thinking by reason of the fact that it has been handed down as a part of some sacred tradition. But testimony itself we usually interpret and judge in terms of our own experience, accepting that which conforms to and is continuous with our experience, and rejecting what is inconsistent with it. If, for example, a traveler from India tells us that a man there was cured of diabetes by the insulin treatment, we will be disposed to believe the story, for there are instances of this causal relation with which we are familiar; if, on the contrary, he tells us that the man was cured by bathing in the river Ganges, we are disposed to scepticism, for our experience affords no satisfactory parallel to such a relationship. How, then, do we come to believe testimony to the occurrence of miracles? Hume notes that when the testimony gains emotional support from the love of wonder, the fascination of the mysterious, and especially by being enshrined in a religious volume or vouched for by a hoary institution which has drawn to itself all our deeper loyalties, the situation is different. Then the tendency to criticize testimony in terms of our own experience falls into abeyance, profound emotional forces lead us into uncritical acceptance of the testimony, so many precious and appealing values would seem to be lost if we disbelieved that dispassionate examination of the evidence cannot quite get under way. In terms of the laws of association, a very vivid association may in this way win out in our thinking in contradiction to what the law of frequency would suggest. Thus such beliefs gain a foothold. Moreover, once believing in divine powers which have worked miraculously in the past, it is easy for the same emotional needs to be brought into play in present situations that are similar, especially where our scientific knowledge about them is yet meager and uncertain. Since this is especially the case in matters of disease, we see many healing cults practicing miraculous cures of various types; the tendency is not so prominent in other realms of life, and fades into insignificance in those intensely practical matters like cooking and sewing, and exact scientific fields like mechanics, where we have been forced to form firm habits of reading our experience in terms of objec-

tive causal laws. To summarize, the principle of frequency, being the only dependable principle of association, tends normally to acquire greater and greater control over our thinking, but in fields where exact causes have not yet been discovered and powerful emotions are rampant, vividness of emotional attachment may maintain or establish a conviction which could not be verified as consistent with the rest of our experience; this is especially possible where the supporting testimony to the conviction is embodied in a sacred tradition appealing powerfully to the deepest emotions of our nature.

The conditions of legitimate belief in extraordinary events

What are the general conditions under which testimony to the occurrence of a miracle can be legitimately believed? Hume formulates the principle to be applied here as follows: "That no testimony is sufficient to establish a miracle unless the testimony be of such a kind that its falsehood would be more miraculous, than the fact which it endeavors to establish."[1] In other words, we weigh, in terms of our own carefully analyzed experience, the probability of the event against the probability of the testimony, and we always reject the greater miracle. Of the two we disbelieve that which has least justification as measured by the relations with which we have become familiar. We have, in short, no business to believe a miracle unless there is stronger evidence for the dependability of the testimony supporting it than for the law of experience to which the miracle is an exception.

These conditions never practically realized

Now in practice, as Hume proceeds to point out, we never actually do discover a miracle of this sort, at least a miracle of the kind that religious people have been tempted to believe in. For on the one hand every uniform law of nature, to which a miracle is an exception, has behind it the fullest possible support from experience; if we had observed cases where it failed to hold, it would not stand as a genuine natural law. Accordingly, there could never be a situation in which testimony could have stronger empirical foundation than that possessed by such a well-established law; its foundation is as strong as any could possibly be. In order, on the other hand, for the testimony

[1] Hume, *Enquiry Concerning the Human Understanding*, Open Court ed., p. 121.

to a miracle to be equally strong, so that we may have a just empirical title to consider its claims, it would have to be publicly performed, among educated and critically minded people, having no personal bias in favor of the miracle and nothing to gain by having it accepted, whose testimony is consistent down to the last detail, and who were present in sufficient numbers so that their deception would have been quite impossible. Where such is the case, we might be justified in considering the alleged exception to an otherwise universal law of experience as very probable, though even then our acceptance of it could not be very confident, due to the pressure on our minds of the experientially confirmed law which it violates. Of course, since we recognize our own experience to be far from all-inclusive, and have to add to it events which we know merely from hearsay, we have no reason wholly to reject an alleged event merely because it is an exception to our personal observation. Particularly in cases that are not isolated occurrences, but continue to be testified to by travelers in the same terms, we may legitimately expand our knowledge by testimony, for in view of our personal unfamiliarity with many causal conditions it becomes far more probable in such cases that the events thus described really occurred than that this stream of testimony is all a conspiracy to deceive us. Our knowledge of the customs of the Eskimos and of the Australian Bushmen will illustrate this sort of expansion. But it can hardly be said that the miracles recorded in sacred tradition, or at least the more startling of them, such as the stopping of the sun's motion or the raising of people from the dead, enjoy these advantages. They are isolated happenings, not repeated nowadays under circumstances which permit checking them up, and the testimony to none of them is of so indubitable a character that we can be absolutely sure there was no mistake or deception. Moreover, when we see how easily, even today, in a more intelligent and critical environment, stories of unusual events and great men take on new dimensions in every retelling, especially where religious enthusiasm coöperates, it becomes easy to understand how sincere and earnest people in a less literate and critical age would be apt to confuse rumors

with realities and magnify every hint of the marvelous, till traditions would be handed down embodying exactly the kind of stories with which our and other ancient scriptures are replete. When we are told, then, that a certain man was raised from the dead by a mere word from a great religious leader, and consider on the one hand such facts as these, on the other, the universal testimony of our experience and that of others of cautious and critical observation that dead people stay dead, how can we reflectively decide that the balance of probability could be in favor of the alleged miracle?

**Not all unusual occurrences to be rejected**

Of course some types of event are loosely spoken of as miracles which ought not in strictness to be so described. Many of the alleged cases of sudden healing without the use of ordinary remedies may be pertinently referred to here. These ought not to be called miracles, because there is considerable contemporary evidence for the hypothesis that under certain not clearly understood conditions changes in mental attitude may bring about definite physiological changes. It may well be, accordingly, that some of the striking events of this sort actually occurred, but it is obvious that when they are viewed in this light they lose the religious value which they have traditionally held. We are assuming, that is, that they happened not because a unique and divine power resided in a certain individual, but because he accidentally became a causal factor in a natural sequence which anyone who learned how could manipulate as easily.

**How, then, about the testimony of the Bible?**

But on this general thesis there is a possible objection to be considered. Since the Bible in general, and Jesus as its focal figure in particular, reveal such a unique moral and spiritual character, does not this fact add dependability to their testimony, so that even though it affirms events which contradict our present experience we may intelligently believe in their occurrence on the strength of such testimony? Is it not more likely that these strange events happened than that a book of such moral grandeur as the Bible would lie? Thus the issue is often stated. But if the alternative is put in these terms the problem is given a deceptive setting. We must bring it back to the test of experience once more. Stated thus, the question

takes this form: *Have we empirical warrant for concluding that unusual moral excellence is necessarily attended with intellectual infallibility, or is there ground for supposing that a great spiritual leader may be occasionally mistaken or deceived?* Faced frankly in these terms, the answer can hardly be in doubt. The fact that such noble men have taught doctrines in some respects conflicting with each other is sufficient witness to the conclusion that moral goodness does not of itself involve the possession of absolute truth. In cases, then, where the lesson of verifiable experience is clear, we can hardly have logical title to accept a contradicting authority whatever its eminence and worth in matters spiritual.

What, then, is the attitude which a logical thinker should take toward a revered ancient book like the Bible? That it affirms as real historical occurrences many events which according to the above principle can hardly be believed in by a clear thinker is obvious. How shall we interpret the meaning and value of such a book? That people are increasingly puzzled by such questions today no one would be apt to deny. And though there is much room for dispute over details, the general answer which must be given is straightforward.

**We must interpret all literature in terms of our own experience**

That general answer is indicated by the conclusion reached above. We can make no headway in the interpretation of the Bible or any other book if we suppose it to describe a type of experience essentially different from our own, for it is only in terms of its similarity with our experience that we can give it meaning or verify its truths. Religious people have often assumed the contrary. They have believed that God's relation to the prophets and apostles was something peculiarly intimate, and unique as compared with experiences of earnest men today; that the revelations thus given have a cogency and finality quite superior to the convictions of contemporary seers; and that the special character of these revelations was vouched for by supernatural happenings that we ought not to expect in our day. The assumption is almost that situations quite incommensurable with ours are to be believed just because they contradict our ex-

perience and testify to a state of affairs of which life today can furnish no corroboration.

Against such an assumption two points need to be brought out clearly. The first is that there can be no justification for assuming this radically different character of the experiences of the Biblical heroes unless it proves quite impossible to interpret the records successfully on the assumption that they are not different. For to suppose a difference gratuitously, where we do not need to do so, is to violate the law of parsimony, than which there is none more fundamental in our thinking; it is as foolish here as anywhere to prefer a more complicated interpretation to a simpler one if the latter will account for the facts. Accordingly, it becomes imperative to examine every phase of the records carefully to see if the assumption of essential similarity can be carried through successfully—and if perhaps the contrary assumption cannot be carried through successfully. The second point is that even if we were completely balked in our effort to interpret the Bible as continuous with our own religious life, this failure would not support the traditional view of the Bible's meaning and value except on an assumption which practically nobody would consciously admit.

Did inspiration in the Bible have an essentially different meaning from what it has in contemporary experience?

Let us consider the first point briefly. We may take it up with reference to any one of several aspects of the Bible stories; perhaps the simplest for the purposes of illustrating our contrast is the question of the nature of the divine inspiration which the writers of the Bible claim as the foundation of their authority. According to the traditional point of view on this matter, this inspiration was something qualitatively quite different from that which underlies the convictions of earnest moral leaders today. God is supposed to have appeared to the seers of old in a direct, overpowering illumination, suppressing the exercise of their natural faculties, and giving them words to speak that were not theirs but His, and carrying with them the authority of His absolute truth. Because, moreover, of their immediate divine origin, these words are assumed to have final authority for us as well as for those to whom they were first addressed. But if we are to interpret the Bible in terms of

contemporary religious experiences, we should see in these inspirations, these "Thus saith the Lord"s, merely the fruit of morally earnest brooding over the challenging problems of one's time, felt by the thinker in question to carry profound religious significance, because of his basically moral interpretation of the meaning of religion. Such inspirations would, therefore, be valuable guiding hypotheses for the religious problems of others, but they could claim no absolute truth, and would not at all be emancipated from responsibility to verification, rejection, or reinterpretation, in the growing experience of those to whom the messages are given. From the one point of view the revelation carries final authority for us whatever the nature of our own religious life; from the other, our experience in religion is final as the test of reality and truth, to verify, modify, or reject through its own sincere trial, the doctrines handed down from the ancients. Which of these methods of interpretation can be carried through consistently?

More precise location of the issue

Well, in favor of the traditional view, at first sight, are those passages in which God is described as appearing to the patriarchs in some visible form, and giving them words while directly present before them—as in his recorded appearances to Abraham, Jacob, and Moses. But such marvelous happenings are true miracles, and if we reach the conclusion about miracles outlined above we can hardly have much confidence in their reality. But except for the mere phraseology in which the inspirations are described, which would be apt to be different in the case of a modern prophet (for he would not be apt to claim such direct divine backing), all of the other recorded revelations can be interpreted as essentially similar in their nature to the appearance of strong convictions in zealous minds today. Men brooded over the puzzling social needs of their time, or sought to understand the spiritual meaning of what was happening around them, and as, out of the welter of this brooding, a fiery conviction dawned across their minds and brought illumination to their faces, accompanied by a touch of mystic rapport with the wider forces in the universe making for righteousness, they burst forth and proclaimed their message as not only theirs, but

God's, as bearing a freight of universal spiritual value. There are passages, however, which it is certainly difficult to interpret consistently on the assumption that the words of the revelation were given directly by the divine author and possessor of absolute, infallible truth. And it is important to note that only one such passage is sufficient to invalidate the traditional conception of the inspiration and authority of the Bible, while as long as we are able to carry through the other mode of interpretation without violating the facts, all the principles of sound reflective procedure encourage us to continue applying it.

**Illustrated by two revelations through Ezekiel**

In the twenty-sixth chapter of Ezekiel we find the prophet proclaiming as a divine revelation the expected destruction of Tyre at the hands of Nebuchadrezzar's army, which was then advancing to invest the seaside city. Ezekiel sees her coming destruction as the divine punishment for her iniquities, and he waxes eloquent in his picture of the complete desolation into which she is to be plunged. Beginning at the first verse of the chapter we read as follows:

> And it came to pass in the eleventh year, in the first day of the month, that the word of Jehovah came unto me, saying,
>
> Son of man, because that Tyre hath said against Jerusalem, Aha, she is broken that was the gate of the peoples; she is turned unto me: I shall be replenished, now that she is laid waste: therefore thus saith the Lord Jehovah, Behold, I am against thee, O Tyre, and will cause many nations to come up against thee, as the sea causeth its waves to come up. And they shall destroy the walls of Tyre, and break down her towers: I will also scrape her dust from her, and make her a bare rock. She shall be a place for the spreading of nets in the midst of the sea; for I have spoken it, saith the Lord Jehovah; and she shall become a spoil to the nations. And her daughters that are in the field shall be slain with the sword: and they shall know that I am Jehovah.
>
> For thus saith the Lord Jehovah: Behold I will bring upon Tyre Nebuchadrezzar king of Babylon, king of kings, from the north, with horses, and with chariots, and with horsemen, and a company, and much people. . . . With the hoofs of his horses shall he tread down all thy streets, he shall slay thy people with the sword, and the pillars of thy strength shall go down to the ground. And they shall make a spoil of thy riches, and make a prey of thy merchandise: and they shall break down thy walls, and destroy thy pleasant houses: and they shall lay thy stones and thy timber and thy dust in the midst of the waters. And I will cause the noise of thy

songs to cease; and the sound of thy harps shall be no more heard. And I will make thee a bare rock: thou shalt be a place for the spreading of nets: thou shalt be built no more: for I Jehovah have spoken it, saith the Lord Jehovah. . . .

. . . I will make thee a terror, and thou shalt no more have any being: though thou be sought for, yet shalt thou never be found again, saith the Lord Jehovah.

In the course of time Nebuchadrezzar made the anticipated attack upon Tyre, but after a hard and long assault failed to take it, and led his army down the coast to Egypt. Accordingly, we find Ezekiel in the twenty-ninth chapter, beginning with the seventeenth verse, prophesying as follows:

And it came to pass in the seven and twentieth year, in the first month, in the first day of the month, the word of Jehovah came unto me, saying,

Son of man, Nebuchadrezzar king of Babylon caused his army to serve a great service against Tyre: every head was made bald, and every shoulder was worn; yet had he no wages, nor his army, from Tyre, for the service that he had served against it. Therefore thus saith the Lord Jehovah: Behold, I will give the land of Egypt unto Nebuchadrezzar king of Babylon; and he shall carry off her multitude, and take her spoil, and take her prey; and it shall be the wages for his army. I have given him the land of Egypt as his recompense for which he served, because they wrought for me, saith the Lord Jehovah.

The second mode of interpretation verified

These passages impose no difficulty on the second of the two modes of interpretation, since they illustrate what we should quite naturally expect if the divine revelations here mean the spiritually challenging yet often fallible convictions that seize upon zealous prophets today. If they are regarded as immediate illuminations, in their exact verbal form, from an omniscient source of perfect truth, it is surely difficult to see how the situation can be made intelligible and consistent. It can hardly be said, of course, that God changed his mind after the first revelation. For on the one hand a God who changes his mind is not omniscient, and on the other, the second passage breathes no hint of a change of mind—the obvious implication is that it was just as desirable still for Tyre to be punished, but unfortunately Nebuchadrezzar had not been strong enough to carry out the punishment. Surely passages like these indicate clearly that our only dependable method of interpreting the

Bible is the one which all other considerations of critical thinking recommend, too, namely the method which proceeds on the assumption of a fundamental similarity and continuity rather than a sharp and mysterious break between the experiences recounted in the Bible and those of contemporary religious leaders.

**But could mystery establish divine authority?**

But now to consider the second point. Suppose we did find a book, or a part of a book, which we could not successfully understand by applying to it the same assumptions and canons which, drawn from the generalizations approved in our present experience or a continuous extension of them under more primitive conditions, would that fundamental dissimilarity establish the divine origin and authority of the writings which thus baffle us? Does the mere fact of mystery, of inexplicability, prove the presence of divinity? Few people, even among traditionalist religious adherents, have really been willing to make this assumption. Strangeness, capriciousness, the sheer violation of law, the bare presence of something different from the familiar, do not constitute a sure mark of the divine. The devil can work wonders and miracles as well as God. If an individual of obviously evil character were to raise the dead to life and feed a vast multitude on a few rolls of bread, few religious folk would regard these marvels as giving divine authority to their performer, and if a book otherwise vulgar and salacious should contain a few mysterious paragraphs or talk about esoteric experiences, they would not, because of that, accept it as a direct revelation of God. In other words, we assume that the true test of divinity is always moral elevation and illumination; apart from that the mysterious exercise of power may prove deviltry rather than divinity.

But note carefully what this involves. It means that in the case of persons or books revealing both moral guidance and miraculous performances, the former must be regarded as the sole aspect which furnishes their divine credentials; since the latter without the former may be a mark of the devil rather than of God, it can add nothing at all to their character as divine instruments. The former would be as much divine without

the latter as with it. That is to say, the miraculous or mysterious element, far from constituting a proof of divine presence, is impotent to add the smallest iota to such proof. Of course, otherwise intelligent people do sometimes worship mystery. But when they do so they are doing something which they themselves could hardly justify by clear thinking; they are simply surrendering for the time being to one of the powerful but quite irrational tendencies of human nature. This is not to say, of course, that the God we worship must not transcend what we are able clearly to understand. It is to say that his nature must be consistent with what clear thinking reveals as far as the latter goes, not inconsistent; God must be harmonious with the intelligible order which we have to assume in all thinking, rather than associated with supposed violations of that order.

**How, then, should a reflective view the Bible?**

But what, then, should be our attitude toward ancient sacred literature such as the Bible? If we are to believe that it affirms as historical occurrences many events which a clear thinker can hardly accept as such, is it our duty to discard the book as entirely worthless? If it is not scientifically accurate, has it no moral or spiritual meaning, either? If we consider the matter a moment we can hardly fail to see that such a conclusion would be quite as illogical as the uncritical acceptance of everything affirmed in the book. Has a great novel, or a moving drama powerfully depicting the spiritual struggles and victories of human life, no value? Surely no one who can read has passed through the age of adolescence without becoming acquainted with some literary product, historically even entirely fictitious, which has yet become a profoundly influential force in the formation of his ideals and the molding of his character. Who can read *Les Miserables* without an enlarged spiritual outlook upon life and the world? Now the Bible, whatever else it may be, is a record of the development of those ideals and aspirations which have become most profoundly moving in the thought and feeling of the Western World—ideals which surely have not yet been realized in all their aspects which still approve themselves before the bar of reflection as challenging realization.

As long, accordingly, as men find themselves facing moral problems that gain illumination by the history of man's spiritual experience as contained in the Bible and other sacred books, the latter will continue to approve themselves as enshrining divine meaning, as inspired in the genuine and fundamental sense in which the word can be used by a clear thinker. To fail to view the Bible in this light, to decline to use its testimony in clarifying the moral perplexities in which we find ourselves from time to time caught, would be as illogical as failure to use demonstrated scientific knowledge to clarify a problem to which such knowledge was pertinent.

**Contrast between this attitude and that of submissive acceptance**

This use of ancient religious literature is of course very different from the use to which many people are accustomed. They think of it as a source of absolute truth, as an authoritative object of final appeal on any matter with which it deals. So far as people continue to think of religion as involving such an authoritative tradition, right thinking and religion will have to remain separate in their experience. For it is surely clear from the considerations thus far adduced in the chapter that real thinking can never accept a standard of truth external to the live present experience in which it finds itself enmeshed. Every question, once it is raised, must be answered if at all in terms which conform to the nature and demands of our present experience. Accordingly, genuine thinking can never regard a past tradition as authoritative in any final sense; its meaning must be formulated and its degree of present validity determined in accordance with the contribution which it can actually make to the solution of the present problem. In so far as the Bible continues to contribute to the satisfaction of deep human needs, its inspirational value is secure and can hardly be seriously doubted, and it is difficult to conceive the time when the great passages from the Psalms, the prophets, and the gospels that have from ancient days entwined themselves with the heart strings of humanity, shall cease to embody guidance and moving power. The Bible is inspired as long as men and women who face earnestly the moral challenge of our own life find it inspired.

So far the discussion has been focused on certain conflicts which obtain in many people's minds between religion and science, and the outcome of the discussion has been that wherever such a conflict does exist the scientific principle and attitude is always the one which must be approved by right thinking. So much, indeed, would be demanded if we were on sound ground in our assumption that scientific method constitutes the objective application of the principles of right thinking, while religious beliefs, being complicated by certain irreducible elements of personal evaluation, form one of the fields that fail to attain true objectivity. But it will seem, then, a pertinent and necessary question to many; what is there left for religious faith that can be approved at all by right thinking? Would it not be better to abandon religion entirely, eliminate its concepts from our dictionaries as soon as we can, and, except for those practical situations demanding immediate action on the basis of some unverifiable value-judgment, devote ourselves to the expansion of empirically verifiable knowledge instead of allowing ourselves to succumb to contemplative reveries, and beliefs intended to rationalize them? Beyond expanding scientific knowledge, and increasing clarification of our practical moral perplexities, religion stands perhaps as a quite futile third system of ideas. Where is there any real reflective need for it at all?

**A more serious question—will right thinking abandon religion entirely?**

It is this type of question that in varying forms and contexts offers the most serious challenge to religion today. The latter is forced to justify its very existence in a profounder way than ever before in human history. In the form in which, in the author's judgment, this question regarding the right of religion to exist becomes most fundamental, it will be frankly faced in our closing pages. Let us lead up to the statement of this issue by further consideration of certain aspects of the present debates about religion and science.

Why is it that many people of strong religious zeal oppose hotly such a scientific doctrine as that of organic evolution? From the standpoint of scientific method and the interest of the scientist in explaining in objectively verifiable ways a cer-

Examination of religious opposition to the theory of evolution

tain field of natural phenomena, there is no more doubt about the validity of the general conception of evolution than there is about the soundness of the Copernican astronomy or of Newton's law of gravitation. All the empirical facts point in the direction of the theory, and none is inconsistent with it. Moreover, the principle of parsimony was never better exemplified in scientific history. The conception of evolution relates together in a comprehensive system facts which would otherwise have to be regarded as quite accidental and meaningless so far as dependable laws of their behavior are concerned (for to say simply that they were created thus by the inscrutable purpose of God is to say that they are accidental as far as human knowledge goes); moreover, it has afforded a principle in terms of which entire branches of science that had hitherto shown few important connections have been organically bound together into a unity. Indeed, almost the entire realm of inorganic and organic science has been reoriented in our day in terms of the general conception of evolution, so enormously fruitful has it been in affording clues of relationship between groups of otherwise distinct facts.[1] If he were to abandon the notion of evolution, the scientist would almost have to give up thinking entirely, so indispensable has it become by reason of this remarkable exemplification of the principles of empiricism and parsimony to the clarification of all his problems. It would be the signal to cease attempting to explain in verifiable ways what happens in the world of nature.

Due in part to loyalty to the authority of the Bible

Why does the fundamentalist attack this conception? In part, of course, because of factors which have already been discussed. For one thing, the Bible offers its own doctrine as to the manner and order in which the various species of plants and animals appeared on the earth, and this description cannot be reconciled with verifiable scientific discoveries at several definite points; indeed, it cannot be reconciled with itself, for if the student will study the first two chapters of Genesis carefully he will find at least two (and perhaps more) different

[1] Examine in this light *The Nature of the World and of Man,* by sixteen University of Chicago scientists.

theories propounded in answer to this problem. One pictures man and woman created together on the last day of creation, as the culminating work of God; the other has man created before the rest of the animal world, and it is only when these brute companions prove inadequate that God introduces woman to the scene. Then, since the fundamentalist is deeply interested in traditional religious values and fails to share or to see importance (at least comparatively) in the scientist's purpose of understanding the world without partiality toward either religious or irreligious preconceptions, it seems to him far more necessary to accept firmly this traditional account than to engage in any enterprise or embark on any type of thinking that would cast doubt upon it.

**But few are willing to make such loyalty fully consistent**

Of course, this attitude of blind acquiescence in tradition as against a demonstrated scientific result can hardly be consistently maintained by anybody, unless he is willing to forswear all the practical advantages that accrue to humanity by reason of the scientific discoveries in question. For whenever the fundamentalist wants to explain why his automobile has suddenly stopped, why his apple-trees have borne heavily, or why customers have dwindled at his shop, he does so by making the same assumptions and pursuing the same verifying technique, so far as logical essentials are concerned, as the scientist has pursued in establishing the theory of evolution. Why does he apply such assumptions in dealing with these matters? Because his practical interests are at stake and he wants to use objective knowledge in a confident way to advance his welfare. So far, then, as he has practical needs which demand for their satisfaction the use of knowledge implying the theory of evolution, he must choose, if he is to be consistent, whether he will forswear these advantages or accept the theory, Bible or no Bible to the contrary. If he choose the former, he can hardly, for example, allow a diseased appendix to be removed by a surgical operation, and indeed there are few processes in the treatment of disease at the present day that do not depend for their justification at some point on the theory of organic evolution, while many were even discovered by the application of

that theory to concrete problems of physiology and bacteriology. It is safe to say that few people will long persist in such a choice in face of the fact that science is so firmly rooted in our practical thinking about live human needs, and if some do attempt such consistency, their children will not be apt to persevere in the serious sacrifices required.

Religious opposition to science, then, is surely playing a losing game, if it be possible to have a type of religion which really affords fundamentally the same kind of satisfaction as religion has always afforded, and is at the same time fully reconcilable with the scientific interest and method. If such a religion is not possible, religion is doomed for all people who consciously endeavor to forsake fallacious modes of thinking, and we all have to share this endeavor where our live interests prod us; for we cannot really continue consistently in any other assumptions than those of science if we are to think at all. In short, we cannot really choose religion and forsake science. If we seem to do so in part, it is because at certain ranges of our thinking reverence for the authority of religious tradition moves us more than the interest in objective understanding and control. But without something of the latter interest we could not live at all.

Is evolution reconcilable with the religious attitude in any form?

But is such a religion possible? If we abandon those aspects of religious faith that conflict with scientific method, what will there be left that will pass under the name of religion? On this the fundamentalist and the contemporary agnostic are apt to find themselves on a common platform. They see no such religion as this in the offing.

Why does the fundamentalist fail to see it? Not merely, it is probably safe to say, because loyalty to the authority of the Bible restrains him. The theory of evolution seems to him to involve, as no previous theory of empirical science has involved, a point of view about man's relation to the universe at large that renders impossible any kind of religion, at least in so far as religion means faith that the things of deepest spiritual value in our experience are somehow embedded in the enduring structure of the universe—that God as the symbol of the final

and eternal unity of factual power and moral excellence really exists, and that in the experience of his reality and of our union with him we too gain ultimate value and eternal life. And were it the case that an established scientific result such as the doctrine of evolution actually involved a view of the universe that would render this faith impossible, many in liberal religious circles would stand on the ultimate issue with the fundamentalist, too.

**The universe from the point of view of evolutionary naturalism**

But see how the matter stands. The theory of evolution proclaims man to be historically derived from a lower order of animals that entirely lack (so far as we can tell) the rational intelligence and moral consciousness—the soul, in short—which give us what high worth we dare ascribe to ourselves. Indeed, it is in terms of a purely natural process of temporal development that it conceives our genetic connection with the simplest single-celled creatures, who supposedly antedated in the temporal order all the more complex forms of life. While it is not inconsistent with this evolutionary picture to suppose a guiding divine hand at work in the stupendous movement, such a supposition is not necessary from the scientist's point of view. He makes no appeal to such a guiding hand; in accordance with his empirical method of interpretation the appearance of the complex out of the simple is to be explained by the tendencies already resident in the latter, just as in common-sense parlance we explain the differences between a boy and his father by appealing to the natural consequences of his heredity and existing environment. If, now, we apply this mode of interpretation, and this alone, to the entire sweep of events that constitute the cosmic drama, we shall inevitably be led to a point of view allowing no satisfaction whatever to religious faith as above expressed. We shall picture the entire stream of cosmic history as beginning with the simplest forms of inorganic behavior, operating in accordance with the most universal laws of electro-dynamics. As certain configurations appear in the course of these electrical changes, more complex bodies arise, which function in accordance with laws less universal in their range of control, the laws of chemistry and of the various branches of physics. In course

of time under the influence of favorable conditions of temperature and the proper mixture of elements already formed, colloid compounds appear, which behave in accordance with still more complex and specific laws, the laws of organic life at its lowest level. Then, under the play of constant variation and the relentless struggle for survival, higher organisms are gradually produced, culminating so far (from our point of view at least) in the human race, which has in the main demonstrated its superiority over the other organisms as regards the general conditions of survival on our planet. But of course the act in which man appears is but a meager and transitory one as far as the whole cosmic drama is concerned. Sooner or later some fundamental change is sure to take place in the underlying climatic conditions on which human life depends, involving perhaps the disappearance of our planet in its present form, and all the values that man has striven for will be destroyed with him and become swallowed in eternal night. The hope of religion that the objects of human spiritual aspiration have an eternal standing in the structure of the universe, and that in union with them we can survive the shipwreck of the material conditions of consciousness, thus appears to be a sheer illusion, born of man's egoistic desire to assure himself a more enduring victory in the ceaseless struggle of cosmic forces than Mother Nature has been able to allow him. The ideal goals of human endeavor depend upon human existence, and human existence is but a brief episode in the play of natural forces whose fundamental character is revealed in the simplest and most universal laws of inorganic change.

**Plausibility of this hypothesis—its conflict with religious faith**

Of course, not every feature of this evolutionary naturalism has been scientifically demonstrated. It has yet to be proved empirically, for example, that life arises out of the nonliving. But in terms of the functional method of explaining any complex event by appealing to its simpler, quantitative, and presumably preëxisting conditions—the method which marks the highest achievements of exact science—so many lines of fact point irresistibly toward this hypothesis that few students of science seriously doubt that it is in this direction alone

that scientific research can fruitfully proceed. And even if we assume that life is irreducible to inorganic matter, we are hardly better off from the standpoint of religious yearning. For there is surely little more in common between the spiritual values of human life and the fundamental features of the evolutionary struggle among the lower animals than there is between the former and the behavior of inorganic matter—perhaps even less, in view of the calm and bloodless play of most inorganic changes. In short, the conception of evolution, when applied in this systematic and comprehensive way over the entire field of scientific study, issues in a conception of the universe that is not only inconsistent with the Biblical account of creation, but inconsistent with the fundamentally idealistic demands of any religious view of human life and its destiny. These demands appear so completely illusory and futile if we accept the point of view thus forced upon us by the evolutionary theory, that there seems to be nothing rationally justifiable left that can properly pass under the name of religious faith at all.

What about the testimony of religious experience?

Why does not the religious man wrench himself free from these illusions, at whatever cost, and face frankly the world not made for him, and in which he becomes but a transitory accident? Not merely, it is to be said, because of unwillingness to accept the bitter pill of fact at such a sacrifice. Surely one cannot enter appreciatively into the classic expressions of religious experience that have come down to us from the pages of the spiritual leaders of history, without recognizing that their ultimate convictions have seemed to them, at least, to be the record of reality and not of mere hope. God has been to them not a dubious inference from a prejudiced selection of facts, but a present object of experience; they have seen Him, have been caught up in His presence, in the illuminating and all-pervading light of the mystic vision they have seen the entire universal drama brought into harmonious and final unity under the control of a loving divine purpose. The intensity and glow of the experience fades, but the conviction remains that the object with which they have been in rapport in the vision is eternally and profoundly real, more real than any object of sense-perception can possibly be. Fortified by the

peace, the stability, the assurance born of this discovery of their eternal value and high destiny, such men have gone forth to proclaim to others the gospel that the material conditions of life do not tell the final story, but that all things, in life or in death, do work together for good to those who know and love God. One cannot read the pages of the religious leaders of history without discovering that such convictions, where they are possible, embody full satisfaction to the profoundest yearnings of humanity. And surely it is clear that one to whom all this is directly experienced fact rather than dubious hope, cannot be refuted by the doctrine of evolution, though he may accept it as far as empirical fact makes it coercive. He will feel quite confident that while the scientific type of explanation may be wholly valid in terms of the interests it expresses, those are not the only legitimate interests, and accordingly this type of explanation is not by itself adequate or complete. The universe is something more than a temporal process in which the only conditions of everything that happens are its simpler, preëxistent, material elements. It has a spiritual, a divine meaning, into which we can enter and in relation to which we can find immortality for whatever within us is morally worth preservation. Science may refuse to appeal to a divine creator, none the less the larger meaning of things can never be understood till they are seen in their relation to a being whom we can only call God.

**Contemporary agnosticism as to such experiences**

What does the contemporary agnostic say to this? Why does he not admit that in addition to the scientific way of viewing events it is legitimate to view them in terms of a mystically conceived divine value, to affirm as real a "far-off divine event toward which the whole creation moves," in contemplation of which we may extricate ourselves from our temporal naturalistic setting and ally ourselves with an eternal good?

Well, he has a rather powerful case to plead, and in the attempt to state considerations which thus bear with increasing vigor upon the thinking of our day let us frankly face the most challenging issue that contemporary religious faith must meet. The agnostic of today, being schooled in the scientific attitude of impartially observing all interesting types of phenomena, will

not be disposed to deny the fact of religious history and religious experience, nor that these facts are such as, to the religious man himself, demand the conception of a real God for their explanation. But this, he will hold, does not at all justify anyone's insistence on the use of such a term to explain them. In fact, he will note a number of considerations which make it highly desirable to ban from our discussions these conceptions of objects of religious faith, and confine ourselves entirely to empirical scientific terminology. What are these considerations?

**As an inference from ordinary experience the conception of God dubious**

In the first place, the agnostic has himself had no such mystic experiences as these, and to him, therefore, the conception of God must represent an inference from empirical fact rather than a directly experienced fact itself. He notices, moreover, that there are many other people like him in this respect; in fact, it might plausibly be maintained that though the majority of people are adherents of some religion, very few have had mystic experiences in the proper sense of the phrase. In the second place, when we examine this notion of God as an inference from empirical fact, we find it certainly a very dubious inference. Viewing what takes place in human life without any partiality in favor of either optimism or pessimism, we shall surely conclude that evil is as real and constant an element in experience as good, ugliness as beauty, tragedy as comedy, moral defeat and disappointment as victory. Medical science overcomes many sources of pain, but new pains just as insistently occupy our attention. Some great moral ideals become practically realized in human life; but in the light of newly glimpsed possibilities, man's lot seems on the whole no better than it was before. And the life of most men is certainly cast in such a dull, sordid, harsh setting as makes a delicately sensitized mind wonder how under such conditions it can be worth living at all.

**And in some of its consequences morally questionable**

In the face of these facts the mystic visions of religious seers seem morally questionable as well as empirically false. At least they are morally questionable if they encourage people to bask in such illusions or merely wander about preaching the reality of God instead of doing what they can actively to help those whose factual lot is such that the notion of a real God is honestly

impossible. If anybody is really sure that the world is caught up in a divine destiny, it is his primary business, granted that he has sincere regard for his fellows, not to hug it as a personal assurance of his own salvation, nor merely to preach it to others less fortunate, but to engage in the active amelioration of those empirical conditions of life that bear tragically upon men and women around him, and render it difficult for them to see life as having any such satisfying meaning. It is his business to live in such a way as will make it easier for others to believe in God through his presence, not to induce people to believe in spite of hard fact. But such a practical program as this can be carried forward without insisting on using the name of God at all; in fact, such insistence might hinder rather than help, so long as the attention of ordinary people is irresistibly drawn to those evils surrounding their existence that seem to refute the notion of God.

**Moreover, religious experience can be described in scientific terms**

In the third place, in so far as it is desirable to talk about these mystic experiences with others, is it not preferable by all odds to use the terminology of psychological science rather than that of religion? The latter is dubious and confusing to many people for the reasons noted above, while the former, being the attempt to understand these experiences in terms of objectively verifiable behavior such as science always appeals to, furnishes a basis of understanding them that can be commonly agreed upon, both by people who have experienced them and value them highly and by those to whom they are foreign or of doubtful value. To insist on the conception of God to explain them is to insist on a vague, dubious, and subjective mode of explanation, while to describe them in the concepts of empirical psychology—to appeal to the concrete practices which the mystic relies upon to produce his vision or the changes taking place in his organism while he is enjoying it—is to recognize a platform of explanation that can be made common to all people who share the scientific interest in securing an impartial understanding of things; it is to express one's willingness to join with others in a common task of explaining without bias what happens in our common world, in prefer-

ence to setting up personal interpretations which many others cannot share.

In short, except for those situations demanding practical decision in which we have to accept for guidance unverifiable suggestions, the agnostic is apt to hold that the terminology as well as the attitude and method of science should be applied without exception, because only so can we hope to secure that objective agreement about the nature of any event that by means of its fundamentally empirical approach science seems able to attain. Religious experiences are no exception. They can be explained either in terms of God, which the religious enthusiast wishes to do, or in terms of the objective behavior of the religious man, which is alone consonant with scientific method. But the latter explanation should be chosen because in the end it is the only fruitful and courteous one.

**But this description omits their essential cance from the religious point of view**

Why the religious man cannot be fully satisfied with this outcome is clear from the discussion above. He may share the scientific interest and attitude, and may be quite willing to accept the objective empirical description of religious experience as far as it goes. But this manner of interpretation does not at all account for that aspect of the experience which alone gives it its value to him, the sense of ultimate at-homeness in the universe through rapport with an eternal and finally controlling spiritual purpose. An explanation that does not explain this seems to him so grotesquely inadequate that he finds it difficult to see in it any significance at all.

**Summary of the issue between these types of thinking**

Here, then, is a pretty deep issue between two types of thinking with respect to religion. Which is right, or at least which is facing in the right direction? By what standard can we tell which is right? If we offer the one answer, science will be debarred from assuming its normal place and filling its rightful and fruitful function in a peculiarly interesting field of human life. If we offer the other, faith in realities akin to the highest ideals that we can glimpse but transcending them by reason of being grounded in the eternal structure of the universe, will appear unscientific and illogical, if not downright immoral. Which way shall we choose, and why?

Both religion and science express basic needs—and perhaps basic facts

Once more it is our business, in this final section, to clarify these great perplexities in our value-thinking rather than succumb to the temptation of attempting an answer. But the profound human interest of religious aspiration, with all that it has meant in the tortuous history of thought, and the peculiar nature of the conflict that has just been stated, perhaps justifies a concluding comment. The religious history of mankind will probably permit the assertion that some kind of faith akin to what men have sought under the name of religion satisfies such a fundamental and peremptory demand, that it will never cease to be cherished in some form, or if not cherished at least pursued as a hoped for consummation. For after all, scientific knowledge and control of the conditions of human destiny are not complete, and in the nature of the case can never be made complete at any finite time in the history of the human race, ultimately dependent as we are on stupendous mechanical forces which in their totality we cannot possibly wield. But in our consciousness of this vast mechanical world, and in our moral aspirations, we outreach it, we know that we transcend it in value if not in power. And this consciousness and this aspiration require for their continued life a conviction of the reality of the transcendent value-character which they possess; they are numbed at the heart if man cannot believe, with a belief that can be intelligently justified, that the acquisition of all scientific knowledge will not profit a man if he lose his own soul—his sense, that is, of the supreme reality of the highest ideals he has been able to glimpse and for the sake of which he lives. To affirm this reality, however, with clear sense of what it involves for one's ultimate point of view about the universe, is to affirm what religious men of all ages have affirmed in their conviction of the existence of God, of an inclusive spiritual purpose for the sake of which these vast material forces function.

On the other hand, one who truly appreciates what objective empirical science has meant and promises to mean in the life of mankind will just as fully expect the extension of this objectively verifiable method of statement and explanation to all events over

which we can have any understanding and control whatever. This will not be mainly because of the remarkable achievements of applied empirical science in assuring man mastery over his physical environment, though these constitute no small reason for the extension of such achievement wherever it can be made effective. The more fundamental reason lies in the democracy of objective science. Scientific method is that method of interpreting events which can be made verifiable and demonstrable to any normal mind really interested in understanding how they happen. Shall this anywhere be surrendered in favor of a mode of explanation which cannot be made objective, which depends on personal, subjective factors? If we share the socially coöperative spirit, the willingness to subordinate one's personal valuations for the sake of meeting others on a common basis of mutual understanding and mutual service, preached as the way of salvation by all great religious leaders themselves, how can we answer this question by anything else than a hearty negative? How can we regard it as other than necessary and desirable to apply scientific reductions and descriptions to all phenomena that seem susceptible of such a mode of attack?

Where lies the standard for right thinking in religion?

Here are two demands and expectations that are surely in conflict. How can they be brought together in harmony? Can the student of the principles of right thinking discover some standard for our thinking in matters of religion that can fully reconcile the ultimate faith of religion with the objective, democratic method of science?

EXERCISE. 1. What form would the issue between science and religion, in which the discussion of the chapter culminates, take with reference to the religious doctrine of the freedom of the will? Does the issue when faced in that form seem any more susceptible of amicable adjustment?

2. How far does this same conflict find expression in the realm of æsthetic appreciation? Why does it not seem as severe or challenging there?

3. What relation do you think holds between belief in immortality and belief in the existence of God? What kind of immortality would you regard as desirable, if any? Is there objective evidence for it? Of what sort would such evidence be?

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## CHAPTER TWENTY-ONE

# A FINAL QUESTION

Does our outcome really support a sceptical conclusion?

THE emphasis of the preceding chapters of the present section has been on problems rather than on principles of thinking. In view of the obvious disagreements of intelligent people on the fundamental issues that arise in the extra-scientific fields discussed, and of the frankly coöperative purpose of the entire volume, this was the only emphasis that could be permitted or justified. But the honest parading of the differences that constitute the problem of logic in these realms may have had an unduly sceptical outcome in the reader's convictions as to the possibilities and responsibilities of thinking on such matters. Do not such basically opposing beliefs, he may say to himself, imply that the effort to establish standards of thinking in these fields is entirely hopeless? The keener a thinker is, the more certain he will be to reach results here that are inconsistent with those reached by others; the simplest conclusion therefore to draw from the situation is that there is no such thing as objective truth on such subjects at all, and that we might just as well remain in what happen to be our present prejudices about them, since even when we have tried to think our way through the maze there will be plenty of equally intelligent people to contradict our conclusions. And, he might add, if the guiding thesis of the present section is sound, lack of objectivity is inherent in the process of valuation which is ineradicable from reflection on these problems. Where then lies the value of engaging in serious reflection here at all? Would it not be an equally or more justifiable policy to desist from any systematic attempt to guide ourselves intelligently in the judgments we pass on matters transcending scientific objectivity?

This too a question of valuation and will be answered variously

Now since this question itself is one of comparative valuation, it is one on which different minds will differ, and the author does not propose to violate the atmosphere with which the discussion of these problems has been surrounded, despite the fact that philosophers are agreed on the supreme desirability of thinking on matters of valuation as vigorously and responsibly as we can. It will be fairer to put the question in this form: What are the factors that encourage such a sceptical feeling about the value of reflection here, and what can be said in support of the conviction that such reflection is most decidely valuable, quite irrespective of the divergent conclusions to which it leads?

The answer to this question has really been given in the early chapters of the book, in which a general comparison of reflection with its possible alternatives was embarked upon, and again in the introductory chapter of the present section. But it will be pertinent to survey the problem again in the light of the ground traversed in the intervening chapters.

Factors supporting sceptical distrust of reflective evaluation

Let us examine the alternative to careful and critical reflection on problems involving valuation, namely a complacent and undisturbed contentment with our present notions about them, except in so far as we are unavoidably and perhaps temporarily jostled out of these notions. The appeal of this policy, as will be realized from the discussion in chapter three, lies mainly in the fact that it involves no intellectual effort, in the heightening of pleasurable emotions arising from the reaffirmation of loyalty to beliefs already become habitual, and in the avoidance of the natural unpleasantness which attends a period of doubt and uncertainty. These forces have some effect on all of us and a very strong effect on those whose minds have never been encouraged to develop habits of intellectual criticism; moreover, in the case of almost all there are certain beliefs that lie so close to our profounder emotions that it is practically impossible to consider fairly an opposing belief—we cannot imagine ourselves deprived of such convictions.

But is it not evident from the entire course of our discussion that it is quite impossible for us to insulate ourselves from the likelihood of falling into difficulties on account of the inadequacies

The impossibility of avoiding problems that force though about values

of these present notions in which we propose to remain? If we adopt the Utilitarian ethics, and there are really certain human situations in which following the Utilitarian principle will lead us to commit acts which we shall subsequently rue, how shall we guard ourselves from the possibility of tumbling into these situations? If we believe that God performs miracles, and it so happen that the universe is such that miracles are impossible, how can we avoid the tragic disappointment of the vain expectancy of miracles occurring in our behalf, in situations which we might have learned to control had we been convinced of the universality of natural law? If we commit ourselves dogmatically to a sentimental idealism in the field of art, are we not preparing for ourselves inevitable æsthetic disappointments in a world characterized more and more by realistic and experimental tendencies in the work of artists? It is hardly necessary to repeat the same theme in reference to the other realms in which the same considerations apply. In short, to attempt to follow this way out of the difficulty is to place ourselves in an inherently unstable equilibrium, to pursue the impossible goal of dictating in the present the nature of all our future problems and insisting that they must be confined within the limits that will permit satisfactory solution in terms of our present opinions. And when we face this fact frankly how can we rest complacently in our traditional notions no matter how strongly we may desire to do so? We must come to hold our beliefs tentatively and flexibly, for we see that something might happen at any time to force us to enlarge or replace them in the interest of solving satisfactorily a real difficulty we had met. We see, in other words, that being what we are, and living in the kind of world we do, the only cure for inadequate thinking is more earnest and persistent thinking.

But in what direction would a stable equilibrium lie? For in some vital sense we all seek it and feel insecure without it. Is not this the answer toward which the entire argument points: It lies in the firm adoption of the readiness to commit ourselves confidently to action on the basis of the best judgments which experience to date permits us to form, coupled with the readiness actively to correct them to whatever extent the most careful

Hence acceptance of the responsibility of constructive thinking the only attitude that can be consistently maintained

reflection on experience shows to be desirable. It involves acceptance of the inevitability of change, and of free, disciplined thinking as the only way of adopting our own process of growth to the changing world. The value, in short, of practical readiness, combined with forwardlooking intellectual tentativeness, is that it may be dependably counted upon to deal as adequately as possible with all other values; and if this be the case, the unreserved adoption of this attitude is the only way to achieve such mental equilibrium as is possible in a dynamic world. It means the gradual transfer of emotional appeal from the specific beliefs which have at present come to entwine themselves about our affections, to the process of continual reconstruction of our beliefs so that we shall prize the attitude of tentativeness more than any notion which might conflict with it. This transfer of feeling is difficult and arouses resistance from all the conservative sides of human nature, but it is not impossible. If we have come to see it as ultimately necessary and desirable we shall find that the forces working toward its attainment have the advantage of constancy while the opposing forces, though more intense, are fickle and transitory.

The realm in which this reconstruction is most difficult is probably that of religion, for the emotional supports of beliefs consecrated by sacred tradition and ritual are most intense. To the deeply pious soul it seems quite impossible that the fervid attachment characterizing his attitude toward the objects of his faith could ever be secured by competing goods; the eternal salvation of himself and of others appears dependent on the maintenance of unquestioning loyalty toward these objects of devotion. But the remarkable rise of liberalism in almost all religious groups in the world today, and the extent of the transformation that has already been brought about within a few decades, shows that even in religion the transfer of devotion from objects that cannot approve themselves to intelligence to those that offer a better title to allegiance, is not only possible but can take place far more rapidly than the most optimistic champions of tentativeness in thinking would have dared to prophesy. In religion, too, the mind that is most apt to win deep satisfaction in a dy-

namic world is the mind that has most fully disciplined its deeper sentiments so that while holding fast to that which has approved itself as good it is yet the readiest to move on to the larger vision that the lessons of experience suggest. In the great leaders of religious history, at least, such reconstructive activity has been felt to be accompanied by the most intense satisfaction of religious feeling; shall we follow them in this central aspect of their prophetic endeavor or by inflexibly attaching ourselves to the specific doctrines they announced?

**Reflection always enlarges experience and clarifies values**

But the sceptical objection needs to be considered in another form. Are you really any farther along when you have engaged in this reflective criticism? Your previous belief was of course inadequate, but you know that your present one is inadequate too; moreover, reflection might destroy the one without being able to supply you with any alternative. Hence you might better have remained where you were. But if we are in any doubt as to the answer to this final stand we shall be freed from it if we consider a parallel situation in a field where the question answers itself. Why eat your dinner, it might be asked, since you know that you are going to be hungry again? And would it not be a mistake to discover that the food you had been eating were poisonous unless wholesome food were on hand so that you might at once turn to it? Surely it is a good thing to solve a present problem even if the solution be unable to maintain itself throughout the entire future. And no matter how far reflection may in the case of a given problem meet frustration, it always leaves us at a more advantageous point in dealing with the matters with which we were concerned than we had reached before—provided we are willing to surrender the spurious satisfactions of the zest for certainty. Even if, for example, we are unable to replace our original æsthetic assumptions by others, reflective criticism will put us in the position where we may see beauty in objects that formerly had no æsthetic meaning for us, while rendering more intelligent our enjoyment of those that previously had aroused our response. Even if we cannot state by precisely what formula "Thou shalt not lie" ought to be corrected, there is no reason why discovery

of its lack of universality should not leave us with the habit of truthfulness in situations where truthfulness is obviously right, while encouraging readiness to transcend it where larger values are clearly at stake. Similarly in the case of other types of value-judgment. In brief, the fact that we have not discovered principles upon which all others will agree, or that we may not have formulated one that will even temporarily satisfy ourselves, should not be allowed to obscure the fact that through reflection our own experience has been enlarged so that while new values have come within our reach all that was dependably valuable in our former objects of attachment is preserved. Because reflection always issues in growth of this sort, whether great or small, philosophers pin their faith upon freedom and vigor of thought as the hope of humanity. In no other direction lies any promise able to command our continued trust.

Appeal to further experience

Doubtless some readers will still fail to find cogency in the supreme valuation thus placed upon reflection. Some values they will wish to protect from its disturbing criticism. Even in their case let there be no dogmatic assertion of the conclusion reached. Let the appeal be to further experience. Clear thinking may not be able to establish objective standards of value, but can any alternative function more dependably as a guide to ends worthy of our loyalty?

# INDEX

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